Torrance
Refining Company

Torrance Refining Company LLC
3700 W. 190th Street
Torrance, CA 90504
www.pbfenergy.com

VIA HAND DELIVERY

February 28, 2018

Sergio Gonzalez
City Manager
City of Hermosa Beach
1315 Valley Drive
Hermosa Beach, CA 90254

Re: ***Information About Modified Hydrofluoric Acid***

Mr. Gonzalez,

The Torrance Refinery has been advised that the City of Hermosa Beach ("City") may be considering whether to adopt a Resolution or approve a Letter of Support to encourage the South Coast Air Quality Management District ("AQMD"), as part of its Proposed Rule 1410 - Hydrogen Fluoride Storage and Use at Petroleum Refineries ("PR 1410") rulemaking to include a phase-out of Modified Hydrofluoric Acid ("MHF") as an alkylation technology, as early as four years from rule adoption.

For all the reasons below, including the supporting documents attached to this letter, we respectfully request that City officials allow the rulemaking process to be completed, rather than consider a Resolution or Letter of Support advocating an MHF phase-out. However, if City officials feel they must take action, we urge them to take a position similar to the City of Torrance supporting the AQMD's PR 1410 rulemaking process.

Setting the Record Straight About MHF

Such a phase-out would only impact two of five Southern California refineries: Torrance Refinery and Valero Energy Corporation's Wilmington Refinery, which supply approximately 30% of Southern California's gasoline demand. We are concerned because the City's consideration of a Resolution or Letter of Support appears to be based on mis- and disinformation being spread about the safe use of MHF at the Torrance Refinery. Particularly, misinformation is being distributed about what might happen if a release of hydrogen fluoride ("HF") were to occur, referring to the potential area impacted as a "circle of death" or "death zone," which is creating fear in South Bay residents, regulators, and elected officials. There is no such circle or zone, and both refineries phased out HF in 1997 (Torrance) and 2007 (Wilmington).

Regrettably, such misinformation purposefully misrepresents the U.S. Environmental Protection Agency's ("EPA") Risk Management Program ("RMP") regulations by referring to Torrance Refinery's ultraconservative emergency "planning circle" as such a zone or circle. The EPA has cautioned that "... planning circles are not intended to represent a 'public danger zone'." This graphic misrepresentation of EPA's planning tool is purposefully misleading and presented out of context -- the equivalent to recklessly yelling "fire" in a crowded theater.

A cursory review of the EPA RMP program would show that many other industries still use unmodified HF in the region, including aerospace companies. This is the same chemical both refineries phased out long ago. Even if the refineries are forced to shut down their MHF alkylation units, there would still be many other facilities using ammonia, chlorine, and other chemicals that have emergency "planning circles" across the South Bay. Like the Torrance Refinery, these facilities are permitted to operate because they properly manage risk and operate safely. In fact, the EPA produced a report on HF in 1993 that stated there was no need for further legislation to regulate the use of the chemical.

Everyone working at the Torrance Refinery recognizes we have to earn the right to operate in the South Bay community. We are committed to safe, reliable, and environmentally responsible operations, and being active in the communities that host us. We have been communicating with public officials and community groups well before taking ownership of the Torrance Refinery on July 1, 2016. We operate with oversight from dozens of agencies at every level of government, in the state with the most stringent refinery safety regulations in the nation and world.

Alkylation produces a key gasoline ingredient – alkylate, which is required to be blended into every gallon of California gasoline. Our Refinery's alkylation unit was built in 1966 using HF as the catalyst, which the Refinery phased out in 1997. Since then, the Torrance Refinery has used a safer, "modified" version of HF, or MHF, which was thoroughly tested by qualified scientists who are technical experts in their fields.

Various safety experts and a Los Angeles Superior Court judge reviewed and approved these test results that showed MHF is a safe technology. In 1997, the AQMD approved an operating permit to use MHF in the Torrance Refinery's alkylation unit, which in 50+ years of operation has <u>never</u> had an offsite HF release, including 20 years using MHF.

In fact, alkylation experts have publicly stated they consider the Torrance Refinery's alkylation unit's redundant safety systems, including the use of MHF, to be among the most advanced in the world. The Torrance Refinery also follows specific, global industry practices for safely and reliably managing this process.

Wilmington Refinery's alkylation unit has a similar record, using HF from 1969 until 2007, when they phased out HF and began using MHF in an agreement with the AQMD, which included the changeover as one of the AQMD's "environmental justice initiatives" in 2003. That refinery has never had an offsite release. Combined, the two facilities have operated for 100 years without an offsite release.

The AQMD issued permits to Torrance Refinery for its MHF alkylation unit in 1997 and Valero's Wilmington Refinery in 2004, after thoroughly reviewing the efficacy of MHF catalyst technology. As noted in these excerpts from a February 2003 AQMD news release announcing that they had entered into an agreement with Valero that required Wilmington Refinery to phase-out and replace HF with MHF technology, the AQMD unequivocally supports and endorses the use of MHF to enhance public safety:

> "Once this refinery stops using concentrated hydrogen fluoride, we will have virtually eliminated the potential for a catastrophic accidental release of this compound in our region," said Barry Wallerstein, executive officer of the South Coast Air Quality Management District."
>
> "The agreement fulfills one of the 23 Environmental Justice goals adopted by AQMD's Governing Board last fall."
>
> "Switching to modified HF will minimize the possibility of a catastrophic accidental release not only at the refinery, but along Southland transportation corridors, as the additive is added to the chemical before shipping."

The Torrance and Wilmington MHF alkylation units have been operating without any offsite release since the AQMD originally issued permits to use MHF. The MHF technology is unequivocally the same today as when the AQMD originally permitted its use in both refineries. However, the safety systems, training, and knowledge of the MHF alkylation process and equipment have improved. Consequently, these MHF alkylation units are even safer today than when the AQMD issued the first operating permits to Torrance 20 years ago.

Despite these facts and safety records, those who want to phase-out MHF advocate for Sulfuric Acid alkylation because they believe the latter technology is safer than MHF and could be installed in four years. However, again they misrepresent the facts.

A Sulfuric Acid alkylation unit is not any safer than the Torrance Refinery's MHF alkylation unit. In 1995, after an extensive technical review of the MHF technology by and recommendation of the Court-appointed Safety Advisor, a well-respected Los Angeles Superior Court Judge approved and required the use of the MHF technology at the Torrance Refinery under the City of Torrance Consent Decree, finding "... that the modified HF catalyst (including mitigation) as safe or safer than a sulfuric acid alkylation plant producing a comparable amount of alkylate."

In addition, Sulfuric Acid alkylation units are three times larger than HF/MHF units. They would effectively increase air pollution - primary air emission concerns are "criteria pollutants" including sulfur oxides; greenhouse gases ("GHG"); and fugitive emissions. These units also consume more energy and have a larger GHG footprint than HF/MHF units. Moreover, these units require a significant amount of acid each month; approximately 1,440 truck shipments per month or about 50 trucks per day if the sulfuric acid is renewed offsite. HF/MHF alkylation units regenerate the acid within the process and only require four to six trucks per month.

After considering these negative environmental impacts, the highly regarded California Energy Commission ("CEC") pointed to the uncertainty of operating permits ever being granted for new Sulfuric Acid alkylation units at Torrance and Wilmington. Plus, even if all the required permits were granted, designing, permitting, and constructing new "grassroots units" would take many years and each refinery would face unique challenges.

Finally, a Sulfuric Acid alkylation unit at Torrance would be cost-prohibitive. A report from Burns & McDonnell's ("B&McD") concludes that the total installed cost to build an equivalent capacity Sulfuric Acid alkylation unit for Torrance would be approximately $600MM, excluding the cost of spent sulfuric acid regeneration. An industry consultant told us a new grassroots, spent acid regeneration plant of sufficient capacity to serve a sulfuric acid alkylation unit at Torrance, or upgrading an existing third-party spent acid regeneration facility, could cost another $300MM, inflating the total estimate to approximately $900MM.

Regarding other emerging alkylation technologies, we have been evaluating alternative alkylation technologies since announcing the acquisition of the Torrance Refinery in September 2015. For example, to explore alternatives to alkylation, we have met separately with experts from Honeywell/UOP, Stratco/DuPont, B&McD, KBR, and CB&I, as well as independent alkylation experts, to explore emergent alternatives. Each of these technology licensors has also provided background information to the AQMD PR 1410 Working Group associated with the rulemaking.

Each licensor has publicly acknowledged their respective alkylation technologies are not commercially viable or cost-effective, especially at the production rates required to replace existing units at Torrance and Wilmington. They have also stated there is no safer alternative alkylation technology than MHF, which is still the most recent advance in alkylation catalyst, while also noting these technologies:

- Are many years away from being commercially proven, safe/reliable, and available;
- Have environmental impacts and process safety operations that are unknown, and
- Will cost as much as, and perhaps more than, a conventional, new grassroots Sulfuric Acid alkylation unit.

Because of the cost and uncertainties of alternative alkylation technologies, a phase out of MHF would jeopardize the viability of the Torrance Refinery because it would no longer be able to produce the cleaner burning CARB gasoline required by law in California. This could result in the loss of approximately 30 percent of southern California's gasoline supply, 30 percent of jet fuel sent to LAX and 65 to 85 percent of the low sulfur Emissions Control Area bunker fuel at the ports. According to the CEC, the closure of the Torrance and Wilmington Refineries could create a 26 cent per gallon or more, increase in the costs of gasoline in the region.

If the Torrance Refinery were to close, not only could there be market impacts as noted by the CEC above, such a closure could impact the Refinery's 570 employees and 300 daily Building Trades and other contractors who rely upon their steady, highly-paid jobs provided by the Refinery to support their families. Additionally, when considering the Refinery's economic multiplier effect, for every Refinery job lost, 15 other jobs throughout Southern California and the state would be eliminated.

Moreover, such a closure would eliminate the support the Refinery provides to 45 community groups and non-profits, City of Torrance programs, and school district initiatives. The taxes and fees that the Refinery pays to fund valuable services that community members rely upon, including police and fire services, parks and recreation programs, just to name a few, would also be reduced or eliminated if the Refinery closes.

Before Taking Action

Accordingly, the Management of Torrance Refinery, on behalf of our employees, contractors, and local vendors, urge that the City listen to both sides of the story and consider all the facts and evidence before taking action on any Resolution or Letter of Support. We invite the City Council and City staff to visit the Torrance Refinery for a tour of our MHF alkylation unit. They can meet the people who run the unit and learn first-hand about the many redundant safety systems we employ that keep Refinery personnel and the community safe. We are confident the combination of MHF and redundant safety systems will contain any potential MHF release onsite, as we have seen since the unit began operating more than fifty years ago.

To further assist in your review of the facts and evidence related to the Torrance Refinery and its safe use of MHF we have prepared the attached binder of documents that include the following:

- **Tab 1**: Alkylation Study Estimate and Reports, Burns & McDonnell, July 2017
- **Tab 2**: Economic Impact of the Torrance Refining Company LLC Torrance Refinery, Capital Matrix Consulting, August 2017
- **Tab 3**: Letter to the Carson Community: USW Members Committed to Safety at Torrance Refinery, November 19, 2017
- **Tab 4**: Potential Transportation Fuel Supply and Price Impacts of HF Ban, California Energy Commission, September 2017
- **Tab 5**: Proposed SCAQMD rule will kill high-paying jobs, hike gas prices: Blanca Rubio, February 20, 2018
- **Tab 6**: Torrance Refinery Alkylation Overview Presentation, 2017
- **Tab 7**: Torrance Refinery MHF Fact Sheet, 2018
- **Tab 8**: Torrance Refinery Myth vs. Fact, Fact Sheet, 2018
- **Tab 9**: Torrance Refinery Overview Presentation, 2017
- **Tab 10**: Torrance Fire Department MHF Presentation
- **Tab 11**: State Building and Construction Trades Council letter to The Honorable William Burke, dated January 17, 2018
- **Tab 12**: Press Release "Highly Toxic Chemical to be Phased Out at Valero Refinery: District, February 7, 2003
- **Tab 13**: City of Torrance Resolution, approved March 29, 2017

In addition, with this letter you will be receiving a spiral bound presentation from the Torrance Refining Company called "*Setting the Record Straight, The Truth About Torrance Refinery MHF,*" which takes Torrance Refinery Action Alliance ("TRAA") presentations and provides the facts behind their myths about MHF. Our report presents the facts based on testing, modeling, and research by qualified experts, correcting misinformation in the presentations by TRAA ("The Case Against MHF, -ARF-SRI-and Barriers-" (January 4, 2017) and TRAA's feedback to Torrance Fire Department (February 28, 2017).

* * *

In closing, the Torrance Refining Company is confident that the many layers of protection, safety systems and mitigation measures built into our MHF alkylation unit allows the Refinery to operate, safely, reliably, and in an environmentally responsible manner. MHF is the newest, most advanced alkylation catalyst technology available today and the Torrance Refinery's MHF alkylation unit with its current safety systems is the best and safest alkylation process for Torrance Refinery.

No emerging alkylation technology has reached the mature state of technological, economic, or commercial viability achieved by MHF or sulfuric acid alkylation. Until a newer technology is proven to be inherently safer than MHF alkylation, feasible, cost-effective, commercially viable on a similarly-sized commercial unit, and consistent with the California's environmental goals, the **only viable option for the Torrance Refinery at this time is MHF**, which we are required to use under the terms of the Refinery's Consent Decree with the City of Torrance.

We are continuously looking for opportunities to further improve Refinery operations. To this end, we are in discussion with the AQMD and other agencies about additional enhancements we can make to the Torrance Refinery's MHF alkylation unit to further enhance its already redundant safety systems.

For all these reasons, we encourage the City to not adopt a Resolution or Letter of Support that would support a phase-out of MHF. However, if the City feels that it must take some action, we ask the City to take a position similar to the City of Torrance and support the AQMD's PR 1410 rulemaking.
If you have any questions concerning this letter or attachments, or would like to visit the Refinery for a tour of the MHF alkylation unit, please contact Betsy Brien, External Relations Manager, at (562) 227-0012 or me at (310) 212-4500.

Sincerely,

Steve Steach
Refinery Manager

Attachments (2)

cc: Nico De Anda-Scaia, Assistant to the City Manager, hand delivery
Betsy Brien, PBF Energy
David Ingram, Torrance Refining Company
Barbara Graham, Torrance Refining Company
Darren W. Stroud, Torrance Refining Company

Report Brief

Alkylation Study & Estimate

PBF Energy

Torrance Refinery
Project No. 98037

July 2017

EXECUTIVE SUMMARY

Burns & McDonnell (BMcD) was contracted by PBF Energy (PBF) to complete a preliminary study for conversion or replacement of their existing modified hydrofluoric acid (MHF) alkylation unit with a new sulfuric acid (SA) alkylation unit at its Torrance, CA refinery. This study assumes the use of an industry leader's Sulfuric Acid Alkylation Technology. The new alkylation unit was designed to match the current capacity of the Torrance refinery and would produce 30,000 BPD of alkylate product with a mixed C3, C4, and C5 olefin feed from PBF's existing FCC. Site selection, tie-in locations, and existing infrastructure were evaluated by a multidiscipline engineering team from BMcD and PBF through field walk downs. Isobutane (ISO) feed to the process is provided by the existing Sat Gas Unit and from rail imports through existing on-site storage. The alkylation process also produces by-product normal butane and propane which are exported to existing refinery storage. Sulfuric acid consumption by the alkylation process requires a significant quantity of high purity sulfuric acid to be supplied to the unit and generates a significant quantity of spent acid which must be exported from the unit. The spent and fresh sulfuric acid can be shipped from/to an off-site regeneration plant which was the basis for this study. The sulfuric acid consumption rate requires nominally 22 on-road tankers (trucks) per day of fresh acid to be supplied to the refinery and up to 25 trucks per day of spent acid to be transported from the refinery. The fresh and spent acid use the same trucks, so the net truck traffic through the refinery gates would be approximately 25 trucks per day. The alternative of onsite regeneration with a new sulfuric acid regeneration facility was not evaluated as part of this study.

Alkylation Unit Cost Estimate

The total installed cost for the new alkylation unit and associated infrastructure (outside the battery limits - OSBL) is estimated at nominally $600 MM, including an owner's cost of $50 MM provided by PBF. This cost is comprised of $56 MM in direct bare equipment cost, $270 MM in additional direct costs associated with labor and materials and $226 MM in indirect costs. Indirect costs include engineering, construction management, escalation, contingency, and contractor fee. The contingency for this estimate was set at $110.6 MM which represents 20% of the total project cost. Attachment 1 contains the overall estimate summary. Equipment pricing was developed based on budget pricing from the process licensor for proprietary equipment, and BMcD in-house data or vendor budget pricing for the balance of equipment. Bulk material quantities and labor hours were estimated by BMcD's estimating tools and comparison to similar projects.

Comparison To Previous Evaluations

A previous report and estimate was published by the South Coast Air Quality Management District (SCAQMD) in September of 2016. This study provided a review of alternate technologies to hydrofluoric acid (HF) alkylation, and concluded that sulfuric acid (SA) alkylation was the most viable and well-established technology alternative. As part of this previous study, a generic order of magnitude capital cost estimate (stated as ± 50%) was provided for converting an existing HF unit to DuPont's SA alkylation technology. The estimate developed was based on a 25,000 BPD unit, and assumed only the front end reactor section of the alkylation process would require replacement. The estimate was generic in nature and did not include any site specific requirements, or added costs for new infrastructure or utilities that would be required to integrate the unit into an existing facility. Overall the costs stated in the previous report were significantly lower than the current estimate, which accounts for installation of a new SA alkylation unit with all associated infrastructure for the Torrance Refinery. The following summarizes the key differences between the estimate developed by BMcD and the SCAQMD report.

- The SCAQMD report assumed a 25,000 BPD SA Alkylation Unit while the BMcD estimate is based on 30,000 BPD which matches the current alkylation unit capacity at the PBF Torrance facility.

- The SCAQMD estimate assumed an all-in labor rate for construction at $85/hr. This is more reflective of a gulf coast region labor rate, and would be significantly higher for the Torrance area. For the BMcD estimate, an all in labor rate was developed based on current data from work performed in the Torrance Refinery.

- The SCAQMD estimate was based on replacing the front end reaction section of an existing HF unit with the corresponding reaction and refrigeration sections from the DuPont technology. The report assumed that the back end fractionation section of the HF unit could be reutilized in the sulfuric acid process, although they acknowledged that this reuse would require further study to confirm. If feasible, such a conversion would be completed in one of two ways.

    - Build the new facilities adjacent to the existing unit and then "cut over" the required streams during a short shutdown. At the Torrance Refinery, this is not an option as there is not sufficient space available adjacent to the existing HF Unit.

    - Demo the front end of the HF unit and install the new SA unit in its place. The SCAQMD report notes that this type of conversion would require an extended shutdown (6 months or more) to perform demo and replacement of the existing unit. Furthermore, as the alkylation unit is a critical component for overall refinery operation, this extended shut down would likely require a complete refinery shut down for the duration of construction.

The premise of the BMcD estimate is a new grassroots alkylation unit, due to plot plan constraints and the difficulties and additional costs of the conversion detailed above. This new unit would be located in an available plot space at the south end of the refinery.

- The SCAQMD estimate did not account for the multiple sewer systems necessary for a SA alkylation unit including separate higher metallurgy acid sewer/trenches separate from the chemical sewer and oily water sewers. The SA alkylation technology also requires a lined neutralization basin which also appears to be missing from the cost estimate and does not exist in the current HF alkylation unit.

- The SCAQMD report acknowledged the higher power requirements for a SA alkylation unit due to the large refrigeration compressor but did not appear to account for any new electrical infrastructure costs. Based on estimated higher loads for the new unit, and a review of existing infrastructure, additional capacity and electrical upgrades would be required.

- The equipment costs in the SCAQMD estimate appeared to be low based on updated pricing for the licensor provided equipment and BMcD pricing for the balance of equipment based on recent experience.

Tables 1 and 2 below highlight the key scope differences and estimated costs between the BMcD study and the SCAQMD report.

Table 1 – ISBL (Inside Battery Limits) Major Scope Areas (in millions)

Scope Area	Capital Cost ($MM)		Notes
	BMcD	Previous	
Reaction/Refrigeration	~$155	~$112	Primary scope area considered by the previous SCAQMD review. Includes compressor, refrigeration condensers, reactors, acid settlers, compressor suction drum. Primary factors for cost delta in this area are unit capacity, labor rate and equipment pricing.
Depropanizer/Debutanizer	~$55	Not Included	Includes Depropanizer system and Debutanizer system to process byproduct propane and n-butane products.
Deisobutanizer	~$70	Not Included	Includes Deisobutanizer system to recover unreacted isobutane from the reaction system
Acid Blowdown	~$20	Not Included	Includes system to recover hydrocarbon from spent acid, a system to scrub hydrocarbon vents, and a system to degas process waters
Area Development	~$75	Not Included	Includes rack piping, utility piping, utility stations, eyewash stations, area civil development, sewers, trenches, supplemental pipe racks, process control hardware and programming, GC analyzers, and fire protection piping
Total	~$375	~$112	

Table 2 – OSBL (Outside Battery Limits) Major Scope Areas – Specific to Torrance Refinery

Scope Area	Capital Cost ($MM)		Notes
	BMcD	Previous	
Electrical Infrastructure	~$65	Not Included	Includes substation upgrades, new motor control center (MCC), duct bank and wiring from substation to MCC
Cooling tower	~$7	Not Included	Required new at the plot location.
Acid Storage Tanks	~$25	Not Included	One fresh acid tank, one spent acid tank, one swing tank used during inspection/maintenance, scrubber to neutralize tank fumes.
Acid Truck Handling	~$3	Not Included	Station for loading and unloading acid trucks
Rack upgrades and piping	~$75	Not Included	Racks and piping to transport feeds, products and utilities to and from the new alky unit location
Total	~$175	--	

Project Cost Summary

Client:	PBF Torrance	***Rev:***	0
Job No:	98037		
Project Name:	SA Alky	***Estimate Date:***	Apr 11, 2017
Proj. Location:	Torrance, CA	***Est. Class:***	FEP-1

Account	**Alky Reaction Section**	**Fractionation + Balance of Plant**	**OSBL**		**TOTAL PROJECT**
(2) Equipment	$38,681,312	$28,095,945	$5,419,888		**$72,197,145**
(3) Piping	$13,625,221	$45,911,625	$23,594,655		**$83,131,500**
(4) Concrete	$3,981,553	$10,024,714	$12,943,727		**$26,949,994**
(4) Other Civil	$2,631,058	$8,144,733	$5,866,916		**$16,642,707**
(5) Steel	$8,629,040	$10,033,995	$6,424,194		**$25,087,229**
(6) Instrumentation	$3,334,904	$6,764,586	$794,217		**$10,893,707**
(7) Electrical	$7,836,894	$9,287,145	$41,127,921		**$58,251,959**
(8) Insulation	$5,772,345	$7,173,914	$4,581,909		**$17,528,168**
(9) Paint	$598,510	$693,539	$1,962,663		**$3,254,712**
(10) Demolition					
Freight	$1,711,732	$1,769,112	$1,401,525		**$4,882,369**
Heavy Lift	$4,000,000	$4,000,000			**$8,000,000**
Total Direct Costs (TDC)	**$90,800,000**	**$131,900,000**	**$104,100,000**		**$326,800,000**
Constr Mgmt / Genl Conditions					
Home Office Support					
Engineering					
General Contractor Profit					
Total Indirect Costs	**$28,500,000**	**$41,400,000**	**$32,700,000**		**$102,600,000**
Escalation	$3,600,000	$5,300,000	$4,200,000		**$13,100,000**
Contingency	$30,700,000	$44,600,000	$35,200,000		**$110,600,000**
Project Total Costs (PTC)	**$153,600,000**	**$223,200,000**	**$176,200,000**		**$553,100,000**
Owner's Costs					**$50,000,000**
Project Total (TIC)					**$603,100,000**

Project Cost Summary

Client:	PBF Torrance	***Rev:***	0
Job No:	98037		
Project Name:	SA Alky	***Estimate Date:***	Apr 11, 2017
Proj. Location:	Torrance, CA	***Est. Class:***	FEP-1

Account	Labor Cost	Matl Cost	Total Cost
(2) Equipment	$15,759,945	$56,437,200	$72,197,145
(3) Piping	$61,699,621	$21,431,879	$83,131,500
(4) Concrete	$23,264,891	$3,685,103	$26,949,994
(4) Other Civil	$13,218,681	$3,424,025	$16,642,707
(5) Steel	$17,856,067	$7,231,162	$25,087,229
(6) Instrumentation	$5,413,176	$5,480,531	$10,893,707
(7) Electrical	$35,922,690	$22,329,269	$58,251,959
(8) Insulation	$15,634,425	$1,893,743	$17,528,168
(9) Paint	$3,108,389	$146,323	$3,254,712
(10) Demolition			
Freight		$4,882,369	$4,882,369
Heavy Lift		$8,000,000	$8,000,000
Total Direct Costs (TDC)	**$191,877,900**	**$134,941,600**	**$326,800,000**
Constr Mgmt / Genl Conditions			
Home Office Support			
Engineering			
General Contractor Profit			
Total Indirect Costs			**$102,600,000**
Escalation			$13,100,000
Contingency			$110,600,000
Project Total Costs (PTC)			**$553,100,000**
Owner's Costs			$50,000,000
Owner's Contingency			
Third Party Licensing and Technology			
Staff & Expenses			
Asbestos abatement, lead paint removal, contaminated soils remediation,etc			
UG Obstructions			
DCS Program Modifications / Configuration			
Permitting, Sales Tax			
Blinding, cleaning, gas-freeing existing equipment and piping for tie-in			
Startup and Spare Parts			
Total Owner's Cost			**$50,000,000**
Project Total (TIC)			**$603,100,000**

Economic Impacts of the Torrance Refining Company LLC Torrance Refinery

August 2017

Prepared For:
Torrance Refining Company LLC

Prepared By:
Brad Williams
Capital Matrix Consulting

Biographical Sketches

Mike Genest and Brad Williams are partners with Capitol Matrix Consulting (CMC), a firm that provides consulting services on a wide range of economic, taxation, and state-and-local government budget issues. Together, they have over 80 years of combined experience in economic and public policy analysis.

Mike Genest founded Capitol Matrix Consulting (originally Genest Consulting) in 2010 after concluding a 32-year career in state government, which culminated as Director of the California Department of Finance (DOF) under Governor Arnold Schwarzenegger. Prior to his four-year stint as the Governor's Chief Fiscal Policy Advisor, Mr. Genest held top analytical and leadership positions in both the executive and legislative branches of California State government. These included Undersecretary of the Health and Human Services Agency, Staff Director of the Senate Republican Fiscal Office, Chief of Administration of the California Department of Corrections and Rehabilitation, and Director of the Social Services section of California's Legislative Analyst's Office. Mr. Genest received his MPP from the Goldman School of Public Policy at the University of California, Berkeley.

Brad Williams, the lead author of this report, joined Capitol Matrix Consulting in 2011, after having served in various managerial and high-level analytical positions in state government for 33 years. Mr. Williams served for over a decade as the chief economist, and several years as the Director of Budget Overview and Fiscal Forecasting, for the California Legislative Analyst's Office, where he was considered one of the state's top experts on the tax system, the California economy, and government revenues. During his career, he also served as Deputy State Controller and as Executive Director of the California Commission on State Finance. Mr. Williams was recognized by the Wall Street Journal as the most accurate forecaster of the California economy in the 1990s. He received his BA and MA in Economics from the University of California, Davis.

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Introduction

The Torrance Refinery has long had a major economic impact on the Southern California region. The facility started up in 1929 and has been operated by the Torrance Refinery Company LLC (TORC), since July 2016 when TORC took control of the Refinery from ExxonMobil Oil Corporation. The Torrance Refinery is the fifth largest by volume in California.[1] In addition to supplying a very significant portion of California's demand for transportation fuels, the refinery's operations support a large amount of jobs, wages, and sales to its California-based suppliers.

TORC commissioned Capitol Matrix Consulting to estimate the economic impacts of the Torrance Refinery to: the California economy; the Southern California region consisting of Los Angeles, Orange, and Kern counties (which is where the majority of the Refinery's employees and network of suppliers reside); and the City of Torrance. The following sections of this report present the results of our analysis, focusing on:

- The Refinery's annual production and sales;
- The number of jobs and amount of wages paid by the Refinery;
- The amount of purchases made by the Refinery from other California businesses, broken out by industry and geographic region;
- The amount of selected state and local taxes paid by the Refinery; and
- The full impacts of the Refinery in the broader state and regional economies, including estimates of jobs, wages, and sales that are directly and indirectly related to the Refinery's operations.

The estimates in this report are based primarily on data available in February 2017. The estimates include economic impacts of the Torrance Refinery itself, as well as associated commercial and logistics operations located in Los Angeles and Kern Counties.

[1] Source: California Energy Commission. http://www.energy.ca.gov/almanac/petroleum_data/refineries.html

Annual Production and Sales of the Torrance Refinery

Under the TORC's currently 2017 operational plan, average daily production in the Torrance Refinery is expected to be 101,000 barrels of gasoline, 29,000 barrels of jet fuel, and 33,000 barrels of other distillates, liquefied petroleum gases, and related products. As indicated in Table 1, the dollar value of its annual production is expected to be $3.7 billion in 2017, of which $2.6 billion is gasoline, $701 million is jet fuel, and $398 million is other refined products.

Table 1
Torrance Refinery 2017 Planned Output[2]

Category	Barrels Per Day	$ Amount (In Millions)
Gasoline	101,000	$2,556
Jet fuel	29,000	$701
Other	33,000	$398
Total	162,000	$3,655

Although this report does not address the full impacts of the Refinery's output on California's retail fuel markets, it is worth noting that the Refinery's 101,000 barrels of daily gasoline production represents about 10 percent of overall gasoline demand in the state. Also, the Torrance Refinery is one of only 14 in California that produces reformulated gasoline that meets the California Air Resources Board's (CARB) stringent emission standards.[3] Thus, a decline or elimination of gasoline production from the Refinery would have a substantial impact on the price of transportation fuels and economic activity in Southern California and the state.

[2] The amounts in this table represent the total output of the Torrance refinery, whereas the expenditures shown in subsequent tables for employee compensation and purchases from other businesses represent only the California portion of the refinery's expenditures for these items. Thus, a simple comparison of the output shown in Table 1 to the cost-related measures shown in subsequent tables would produce a major overstatement of the refinery's gross earnings before interest, depreciation, taxes and amortization.

[3] Source: California Energy Commission. Reformulated gasoline reduces emissions of gasoline-burning engines. California's reformulated gasoline program was implemented in three phases. Phase 1, which was implemented in 1991, eliminated lead from gasoline and set regulations for deposit control additives and reidvapor pressure (RVP); Phase 2 set specifications for sulfur, oxygen, and other additives; and Phase 3 eliminated methyl-tertiary-butyl-ether (MTBE) from California gasoline and replaced it with ethanol.

Jobs and Wages Paid by the Torrance Refinery

As shown in table 2, TORC directly employs 621 employees who reside in the Southern California three-county region. The Refinery employs workers in a variety of professional, skilled, and high-paying occupations, including engineers, chemists, plant and system operators, and maintenance and repair construction technicians. Also as shown in Table 2, there are another 92 Torrance Logistics Company LLC employees who support the Torrance Refinery that are located in other areas of the state.

Table 2
Jobs, Payroll, and Average Wages Related to Torrance Refinery Operations

Category	3-County Region*	Other CA	Total CA
Number of Employees	621	92	713
Total Payroll ($ Millions)			
- Wages + Overtime	$81.2	$11.9	$93.0
- Benefits	$30.3	$4.3	$34.6
Total, Wages + Benefits	$111.6	$16.2	$127.6
Average Wage, (including overtime, excluding benefits), in 000's	$130.7	$129.0	$130.5

*Includes Los Angeles, Orange, and Kern Counties

Annual wages paid to these employees total $93 million, of which $81 million is in the Southern California region. We estimate that non-wage compensation for healthcare, retirement, and other benefits totals about $35 million statewide, bringing total payments for employee compensation to $128 million. The average wage for these jobs (including overtime but excluding benefits) is $131,000 per year, which is more than double the average wage for all California workers.[4]

[4] Torrance refinery wages are based on company data provided by PBF. The statewide average wage – $63,000 in 2016 – is calculated based on information contained in the *Quarterly Census of Employment and Wages*, provided by the California Employment Development Department.

Purchases From Other California Businesses

In addition to wages and benefits paid to its employees, the Torrance Refinery supports California economic activity through purchases from its network of suppliers in the state. As shown in Table 3, the Torrance Refinery related operations make $2.1 billion in annual purchases from California-based suppliers, the great majority of which are in the Southern California three-county region.

Table 3
Torrance Refinery Purchases From Other California Businesses

Purchases ($ Millions)	3-County Region*	Other CA	Total CA
Crude Oil (excluding transportation costs and regulatory fees)	**$1,649**	**$0**	**$1,649**
Contracts, Materials, and Services:			
- Utilities	$84	$24	$108
- All other (detail in Table 6 below)	$304	$18	$322
Total, Contracts, Materials, and Services	**$388**	**$42**	**$430**
Grand Total, All Purchases	**$2,038**	**$42**	**$2,080**

* Includes Los Angeles, Orange, and Kern Counties

Crude oil. By far, the largest purchase from California suppliers is for crude oil. The Refinery purchases an average of 96,000 barrels of California crude per day, which is worth about $1.6 billion annually. These purchases represent 19 percent of total in-state crude oil production.[5] In 2017, most of the crude oil purchased by the Refinery is expected to be shipped via pipeline from producers in Kern County, with smaller, but still significant, amounts received from suppliers within the Los Angeles Basin.

Other contracts, materials, and services. In addition to crude oil, the Torrance Refinery spends $430 million in California annually for other contracts, materials, and services. Of this total, we estimate that $388 million is from businesses within the Southern California three-county region, and another $42 million is from sources in other parts of the state. Table 4 indicates that purchases by the Refinery support businesses in a wide range of industries, including utilities, rail and pipeline transportation, maintenance and repair construction, engineering services, wholesale trade, manufacturing, and waste management and remediation services. As discussed more fully below, these purchases generate a large number of jobs, income, and business sales throughout the Southern California region. For example in 2017, a daily average of over 600 building and trade union contract workers are performing maintenance services at the Refinery, with as many as 1,800 working during peak turnaround maintenance periods.

[5] According to the U.S. Energy Information Agency (EIA), crude oil production in California averaged 508,000 barrels per day in 2016.

Table 4
Distribution of Torrance Refinery Purchases By Industry ($ Millions)

Supplier Industry	3-County Region*	Other CA	Total CA
Crude Oil (excluding transportation costs and regulatory fees)	**$1,649.00**	**--**	**$1,649.00**
Contracts, Materials, and Services:			
- Utilities	$84.38	$23.73	$108.11
- Chemical manufacturing	$45.62	--	$45.62
- Maintenance and repair construction of nonresidential structures	$45.13	--	$45.13
- Rail Transportation	$29.74	$7.44	$37.17
- Architectural, engineering, and related services	$35.33	--	$35.33
- Petroleum Storage	$27.16	--	$27.16
- Commercial and industrial machinery and equipment rental and leasing	$25.31	$0.85	$26.15
- Wholesale trade	$22.07	--	$22.07
- Industrial gas manufacturing	$11.62	$2.70	$14.32
- Cargo shipping/terminal fees	$11.33	0	$11.33
- Waste management and remediation services	$7.62	--	$7.62
- Commercial and industrial machinery and equipment repair and maintenance	$3.50	$3.81	$7.31
- Pipeline transportation	$5.43	--	$5.43
- Scales, balances, and miscellaneous general purpose machinery manufacturing	$5.26	--	$5.26
- Environmental and other technical consulting services	$4.79	--	$4.79
- Water, sewage and other systems	$4.05	--	$4.05
- Services to buildings	$3.16	--	$3.16
- Employment services	$2.24	--	$2.24
- Valve and fittings, other than plumbing, manufacturing	$1.80	--	$1.80
- Investigation and security services	$1.53	--	$1.53
- Other	$12.90	$3.54	$16.44
Total, Other Contracts, Material, and Services	**$388.43**	**$42.07**	**$430.50**
Grand Total	**$2,037.43**	**$42.07**	**$2,079.50**

*Includes Los Angeles, Orange, and Kern Counties

State/Local Taxes and Charitable Contributions of the Torrance Refinery

The Torrance Refinery pays about $30 million annually in state and local sales taxes, utility user taxes, and property taxes (see Table 5). This does not include additional taxes paid by its employees on their salaries and purchases (which we estimate to be about $8-9 million annually), nor does it include California corporate income taxes paid on the combined earnings of the Refinery's parent company, PBF Energy Inc. The Refinery also makes several hundreds of thousands of dollars in charitable contributions to entities within its local community.

Table 5
State/Local Taxes Paid by Torrance Refinery ($ Millions)

Tax Category	3-County Region*	Other CA	Total CA
Sales and Use Tax on Purchases (Estimated)	$3.43	$6.87	$10.31
Property Taxes	$11.81	$0.00	$11.81
Utility Users	$7.46	$0.00	$7.46
Total	**$22.70**	**$6.87**	**$29.58**

*Includes Los Angeles, Orange, and Kern Counties

These totals also do not include regulatory taxes, fees and related expenses incurred by the Refinery. These include fees, but are not limited to: the federal renewable fuel standards program; the federal oil spill liability tax; local, state, and federal permitting; local, state, and federal annual emissions and discharges; emission allowance payments required by California's Cap-and-Trade carbon emission-reduction program; and California's Low Carbon Fuel Standard program. The combined cost for these levies varies from year to year, but generally runs in the mid-to-high tens of millions of dollars annually.

Full Economic Impacts of the Torrance Refinery on the Broader Economy

In this section, we present our estimates of the full economic impacts of the Torrance Refinery on California and the Southern California three-county region. We also break out the impacts for the City of Torrance ("City").

The full impacts includes both the direct impacts discussed above – that is, the jobs, wages and output of the Refinery itself – as well as the multiplier effects of the Refinery's activities on other sectors of the economy. These multiplier effects include:

- The indirect impacts of the Refinery's expenditures – that is, the subsequent rounds of production, employment, and wage payments that occur as the Refinery's contractors (and their suppliers) step up hiring of workers and their own purchases of inputs needed to produce the goods and services purchased by the refinery.

- The induced effects related to subsequent rounds of production, employment, and wages that arise from spending by households of the refinery and its contractors.

We estimated these multiplier impacts using the IMPLAN model for California and the three-county region of Los Angeles, Orange, and Kern, and for the City of Torrance. Further descriptions of the IMPLAN model and the specific steps involved in our analysis are included in the Appendix to this report.

Results For California and 3-County Region

Table 6 summarizes our results for the Southern California three-county region and the full state of California. It shows that over 11,000 jobs, $1 billion in wages, and $7 billion in total sales in California are currently tied, directly or indirectly, to the Torrance Refinery. Approximately 98 percent of the total sales and 95 percent of jobs and wage payments are attributable to businesses and households located in the Southern California region.

Table 6
Full (Direct + Multiplier) Economic Impact of the Torrance Refinery: Including Purchases of Crude Oil

	3-County Region*			California		
Type of Impact	Jobs	Wages ($ Millions)	Sales ($ Millions)	Jobs	Wages ($ Millions)	Sales ($ Millions)
Direct Impact	621	$81	$3,655	713	$93	$3,655
Multiplier effects:						
- Indirect	5,656	$719	$2,440	5,855	$731	$2,499
- Induced	4,196	$224	$996	4,505	$244	$1,052
Total Impact	**10,474**	**$1,024**	**$7,091**	**11,073**	**$1,068**	**$7,206**

*Includes Los Angeles, Orange, and Kern Counties

The statewide totals include direct effects of 713 jobs, $93 million in wages, and $3.7 billion in production attributable to the Refinery itself. The totals also include about 10,000 jobs, $1 billion in wages, and $3.6 billion in sales attributable to businesses supplying goods and services to the Refinery and its contractors (the indirect effects), as well as the households of the Refinery's employees (the induced effects).

The major indirect and induced effects result in extremely large multipliers, particularly for jobs and wages. The job multiplier (defined as the ratio of total jobs to direct jobs) is over 15, which is more than 7 times that of most other California industries (which are typically in the range of 2 or less). The wage multiplier is a similarly large 11.

These large multipliers are typical for the refining industry. They reflect both the high volume of inputs of crude oil and other products needed to support the refining process, and the large amount of expenditures for parts, supplies, and maintenance needed to maintain safe and reliable refinery operations.

Stated another way, in addition to the hundreds of Torrance Refinery employees involved in managing the production of refined petroleum products, it takes thousands of employees in supplying industries to extract and distribute the crude oil to the Refinery, as well as to produce and distribute other supplies and services needed by the Refinery each year.

What would happen to California crude oil production if the refinery closed?
The large multiplier effects shown in Table 6 include economic activity related to the production of crude oil in California that is purchased by the Torrance Refinery. The inclusion of crude oil production is appropriate when measuring the full scope of economic activity currently supported by the Refinery. However, when considering the potential impacts of a Refinery shutdown on crude oil producers, an important question to consider is whether crude oil producers respond to the shutdown by curtailing their output or by redirecting the heavy crude oil to other refineries.

The market for crude oil is global in nature, so in theory, California producers could redirect their supplies to other destinations. In this case, the economic impact of a refinery shutdown on California crude oil production would be relatively minor. In reality, however, a redirection of California crude oil to other destinations would likely involve significantly higher transportation costs, given that suppliers would need to find other, potentially more remote refineries that are capable of processing California's very heavy crude oil. Efforts to redirect crude oil to nearby destinations would be hampered by the extremely limited amount of unused refinery capacity in California and other states available to produce gasoline that meets CARB's stringent emission standards. Crude oil producers would also need to find alternative modes of delivery that are likely to be more expensive than the efficient pipelines currently used to deliver oil to the Torrance Refinery. Combined, these factors imply that production of the crude oil currently being shipped to the Torrance Refinery would be at serious risk if the Refinery were to shut down. It would be particularly vulnerable if crude oil prices remain low.

Even if producers were able to find suitable alternative markets for their heavy crude oil, and hence crude production activity was unaffected, the impacts of a shutdown of the Torrance Refinery on other supplying industries would still be enormous. As indicated in Table 7, a shutdown of the Torrance Refinery would impact over 4,300 jobs in businesses that provide supplies (other than crude oil) and services to the Refinery and households of its employees. One obvious example is the 1,800 contract workers who are on-site during peak refinery maintenance periods. Other industries affected range from engineering to pipeline transportation. Nearly $400 million in wages and $4.6 billion in sales would also be at risk if the Torrance Refinery were to close.

Table 7
Full (Direct + Multiplier) Economic Impact of Torrance Refinery: Excluding Purchases of Crude Oil

Category	3-County Region*			California		
	Jobs	Wages ($ Millions)	Sales ($ Millions)	Jobs	Wages ($ Millions)	Sales ($ Millions)
Direct impact	621	$81	$3,655	713	$93	$3,655
Multiplier effects:						
- Indirect	2,170	$177	$553	2,500	$201	$646
- Induced	1,443	$77	$224	1,812	$99	$289
Total Impact	**4,233**	**$335**	**$4,431**	**5,025**	**$393**	**$4,590**

*Includes Los Angeles, Orange, and Kern Counties

Impacts on the City of Torrance

The City of Torrance receives significant economic and fiscal benefits from the operation of the Torrance Refinery. About 80 of the refinery's employees reside in the City and receive $11 million in wages annually. In addition, over a dozen local businesses supply materials and services to the Refinery, including engineering, maintenance and repair construction, security, and building services. Including multiplier effects, the Refinery supports 362 jobs and $30 million in wages in the City of Torrance.

Table 8
Full (Direct + Multiplier) Economic Impact of Torrance Refinery On the City of Torrance

Category	Jobs	Wages ($ Millions)	Sales ($ Millions)
Direct effects	80	$11	$3,655
Multiplier effects:			
- Indirect	179	$13	$30
- Induced	103	$6	$13
Total Impact	**362**	**$30**	**$3,698**

In addition to the various economic benefits, the City receives $7.5 annually million in utility user taxes from the Refinery. It also receives hundreds of thousands of dollars in local sales and property taxes related to economic activity generated by the Refinery and its employees.

Conclusion

In addition to its crucial role of supplying a significant share of gasoline and related refined transportation fuels and petroleum products to the California market, operations of the Torrance Refinery directly and indirectly support over $7 billion in annual sales, 11,000 jobs, and $1 billion in wages in the California economy each year. The great majority of these impacts are in the Southern California region consisting of Los Angeles, Orange, and Kern counties, where most of its workers and suppliers reside. The Refinery also pays $30 million in utility, property, and sales taxes, as well as hundreds of thousands of dollars to support civic and community activities to benefit the general public. Beyond these totals, state and local governments benefit from multiple millions of dollars in taxes and fees paid by the Refinery's workers and suppliers each year. All of these economic and fiscal benefits would be at risk if the Refinery's operations were curtailed or shut down.

Appendix – Brief Description of IMPLAN and Our Methodology for Estimating the Full Economic Impacts of the Torrance Refinery

IMPLAN is an input-output modeling system that enables users to calculate the direct, indirect, and induced effects of output and/or spending in one industry on other industries located within a geographical region (national, state, county, metropolitan statistical area, or zip code). IMPLAN is widely used by academic institutions, federal, state, and local government agencies, and private companies for economic impact analyses.

The model is based on benchmark U.S. input-output accounts produced by the U.S. Bureau of Economic Analysis (BEA). These accounts describe commodity inputs that are used by each industry to produce its output, the commodities produced by each industry, and the use of commodities by final consumers. The relationships in the national accounts are then modified by IMPLAN for each local region to take into account such factors as the relative size of the region's various industrial sectors. Based on these inter-industry tables, IMPLAN calculates a total requirements table, which estimates the full impacts (including multiplier effects) of a given change in output in one industry on all other industries in the economy.

Our Methodology. Our estimates of the full multiplier impacts of the Torrance refinery are based on the following steps:

- First, TORC provided us with a de-identified listing of its employees and wages, allocated by the geographic region of most employees' places of residence. It also provided us with payments to its California vendors made during the second half of 2016 for inputs such as crude oil, utility services, transportation services, chemicals, valve and piping components, construction, and maintenance services. We annualized the vendor data to derive an initial estimate of full-year expenditure totals, and then made a modest upward adjustment to some expenditures to reflect the higher amount of major refinery maintenance scheduled from 2017 through 2020 under TORC's multi-year capital plan.

- Second, using information in the vendor database, along with online company search services, we allocated the vendor payments to geographic location and industrial classifications. We then entered these expenditures by industry into the IMPLAN regional models. We similarly allocated the distribution of wages, by income level, into the models' household sectors.

- Third, we used the total requirement tables from the IMPLAN model to determine the full impacts of the refinery on the economy. The full effects, which include both direct and multiplier impacts, take into account the jobs, wages, and output of businesses supplying goods and services to the refinery as well as to the households of its employees.

Paid Advertisement

Letter to the Carson Community:

USW Members Committed to Safety at Torrance Refinery

United Steelworkers Locals 675 and 407 proudly represent 320 members who work at the Torrance Refinery and related logistics operations in Southern California.

We are your neighbors. We live and volunteer in local communities. Our children go to nearby schools and enjoy playing in local parks. Our families and neighbors are among the reasons why everyone in the USW is committed to operating the refinery safely.

We know you want to live in a safe community - similarly we want to work in a safe workplace, so safety is a priority we share with you.

Torrance Refining Company LLC (TORC), the operator of the Torrance refinery, is committed to working closely with us and each job our members perform involves safety. TORC listens – we talk about operations and our voices are heard and respected. As part of their commitment to improving reliability, the company invested more than $200 million in the refinery earlier this year. Now they are investing in our members through an extensive training program.

Just like some other members of the community, we are concerned about the hydrofluoric acid (HF) that some refineries use as an alkylation catalyst. However, Torrance uses a safer form of catalyst called modified hydrofluoric acid (MHF).

The safety and use of MHF has been the subject of speculation and misrepresentation by this newspaper, certain public officials, and community activists, none of whom have any refining experience.

In contrast, the USW is well-qualified to understand the risks and explain our position on this complex technical issue because we have been monitoring technical developments related to alkylation for 70 years. Today we have 7,000 members working in 28 refineries that utilize alkylation catalysts based on HF, which includes both “HF” and “MHF.”

Our members work with MHF on the Torrance alkylation unit. We know MHF has an effective additive that prevents the mixture from vaporizing if accidentally released. Instead, the additive helps form droplets that fall to the ground as a liquid, rather than creating a vapor cloud. Barriers at Torrance also stop MHF from forming a cloud.

There are about 140 refineries in the U.S. today and 89 of them have alkylation units for making cleaner-burning gasoline. Fifty of them use either HF or MHF as a catalyst, while 39 use sulfuric acid, which is also extremely dangerous. If Torrance switched to sulfuric acid, as some suggest, more than 1,400 tanker trucks carrying sulfuric acid would travel past Torrance homes, churches and schools every month, versus six trucks today.

Despite claims by others who are unauthorized to speak on our behalf, since 2013 we have been recommending that refineries switch from HF to the MHF used by the Torrance and Valero Wilmington refineries today.

This newspapers and local activists have attempted to discredit the effectiveness of MHF by attacking the scientific testing, modeling, and related data that support MHF, as well as the people involved in those initiatives. However, results of these research findings were reviewed and affirmed by a highly-qualified, independent court-appointed Safety Advisor and consultants for the City of Torrance Fire Department. The Safety Advisor’s recommendation to the Court became the basis for the Consent Decree governing the Torrance refinery that requires MHF to be used in the alkylation unit, an agreement that is still in effect. Additionally, the South Coast Air Quality Management District (AQMD) issued air permits to the Torrance refinery in 1997 and Valero Wilmington refinery in 2007 to allow the use of MHF as an alkylation technology.

There’s never been a refinery anywhere in the world that converted from MHF to sulfuric acid alkylation. In our opinion, if AQMD now requires refiners to build or convert to sulfuric acid alkylation, the decision would lead to shutdowns of both refineries, forcing the loss of thousands of direct and indirect jobs. And there’s no guarantee an air permit would be issued because sulfuric plants create more emissions than MHF alkylation units.

In a report on the AQMD website, the California Energy Commission estimates that motorists and businesses would pay added costs of $5.6 billion if the refineries shut down. This would be similar to 2015 and 2016 when Torrance was partially shut down following an incident under prior ownership, when California had to rely on fuel imported from other regions and countries to meet demand.

For these and other reasons, the USW and its South Bay locals oppose forcing either refinery to build a sulfuric acid alkylation plant.

Although two promising alternatives we support have been in development for decades, licensors of both technologies reported at the August 2nd AQMD meeting that neither process is commercially proven. We also confirmed through reputable labor and industry sources there is no solid acid catalyst alkylation unit in the UK, despite erroneous claims by an AQMD consultant.

The AQMD seems to have forgotten their own findings and agreements supporting MHF, which they termed an “environmental justice initiative” when Valero agreed to voluntarily convert its Wilmington HF alkylation unit to MHF in 2003. Former AQMD Executive Officer Barry Wallerstein praised the “enforceable agreement” in the District’s 2003 news release:

“Once (Wilmington) stops using concentrated hydrogen fluoride (HF), we will have virtually eliminated the potential for a catastrophic accidental release of this compound in our region.”

“Switching to modified HF will minimize the possibility of a catastrophic accidental release not only at the refinery, but along Southland transportation corridors, as the additive is added to the chemical before shipping.”

The record shows the Torrance refinery alkylation unit has been safely operating without any offsite HF release since 1966 when the unit started up, through the Sylmar (1971) and Northridge (1994) earthquakes, and 20 years of MHF use since 1997.

Our members are proud to make the cleanest gasoline, jet fuel, and diesel in the world, literally fueling California’s economy and our quality of life. We work with MHF every day and know the additive is safe and effective. The USW will continue supporting our members and their families while promoting MHF alkylation as the safest alkylation catalyst available until an inherently safer and commercially viable alternative is proven, available, and cost-effective.

UNITED STEELWORKERS

USW®

UNITY AND STRENGTH FOR WORKERS

LOCAL 675

Potential Transportation Fuel Supply and Price Impacts of HF Ban

Proposed Rule 1410

Working Group Meeting #6

Toyota Meeting Hall, Torrance, CA

September 20, 2017

Gordon Schremp

Energy Assessments Division

California Energy Commission

Gordon.schremp@energy.ca.gov

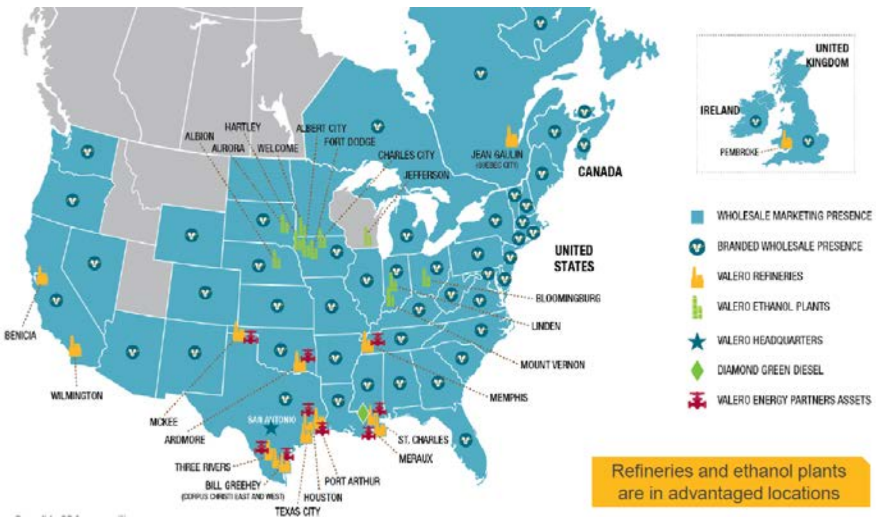
Presentation Topics

- Refinery assets – portion of larger portfolio
- Capital for refining projects
- Investment decision guidance & approved projects
- Likelihood of alkylation replacement
- Implications for regional supply, fuel prices, competition, and contingency planning

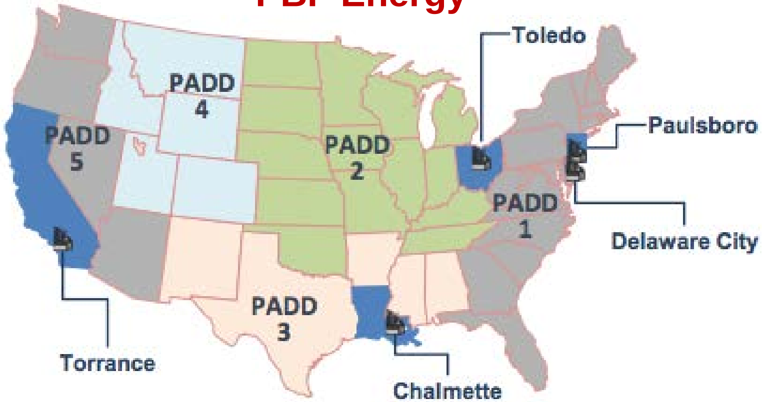
Refinery Assets

Refineries & Locations

Valero Energy

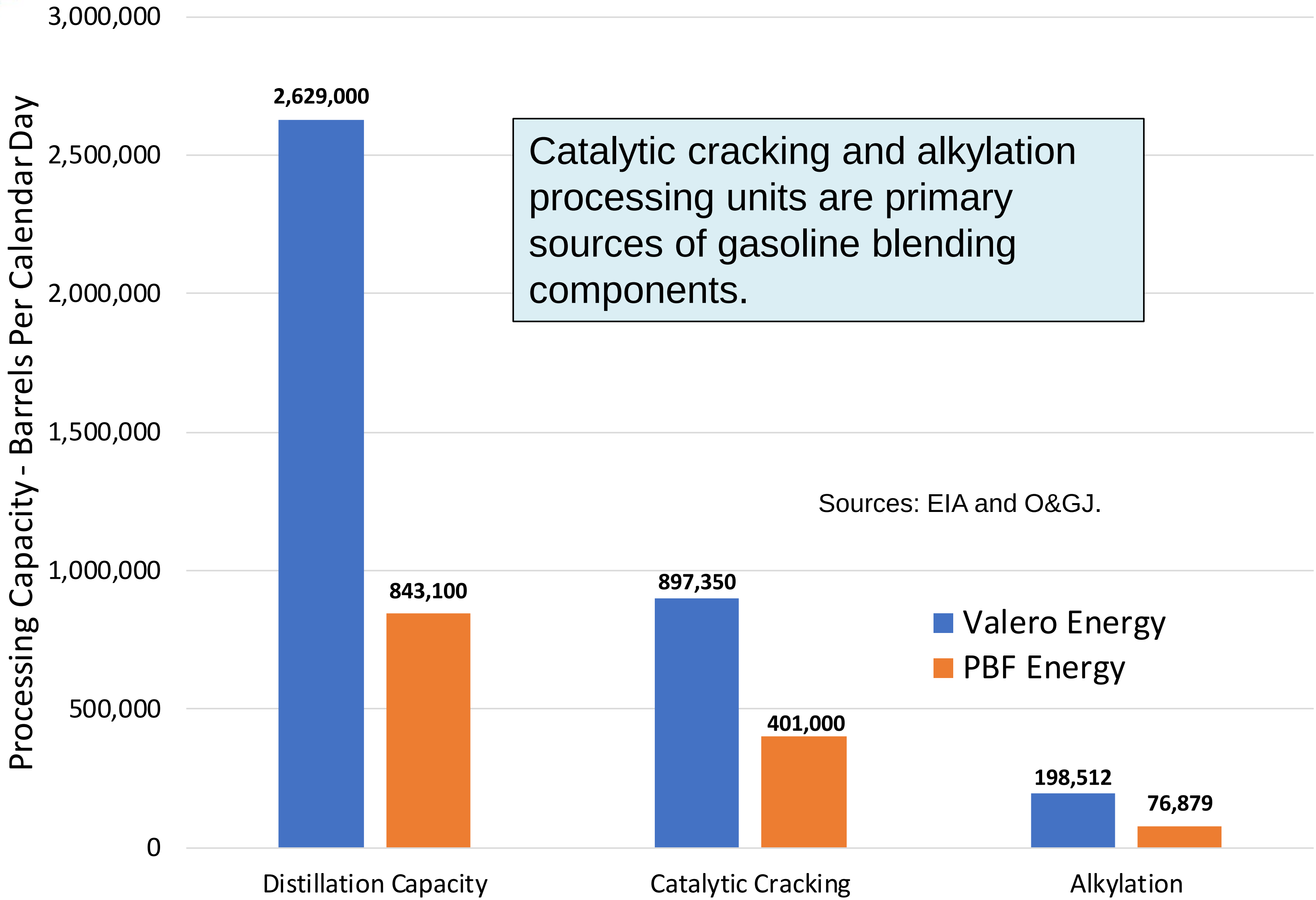


PBF Energy

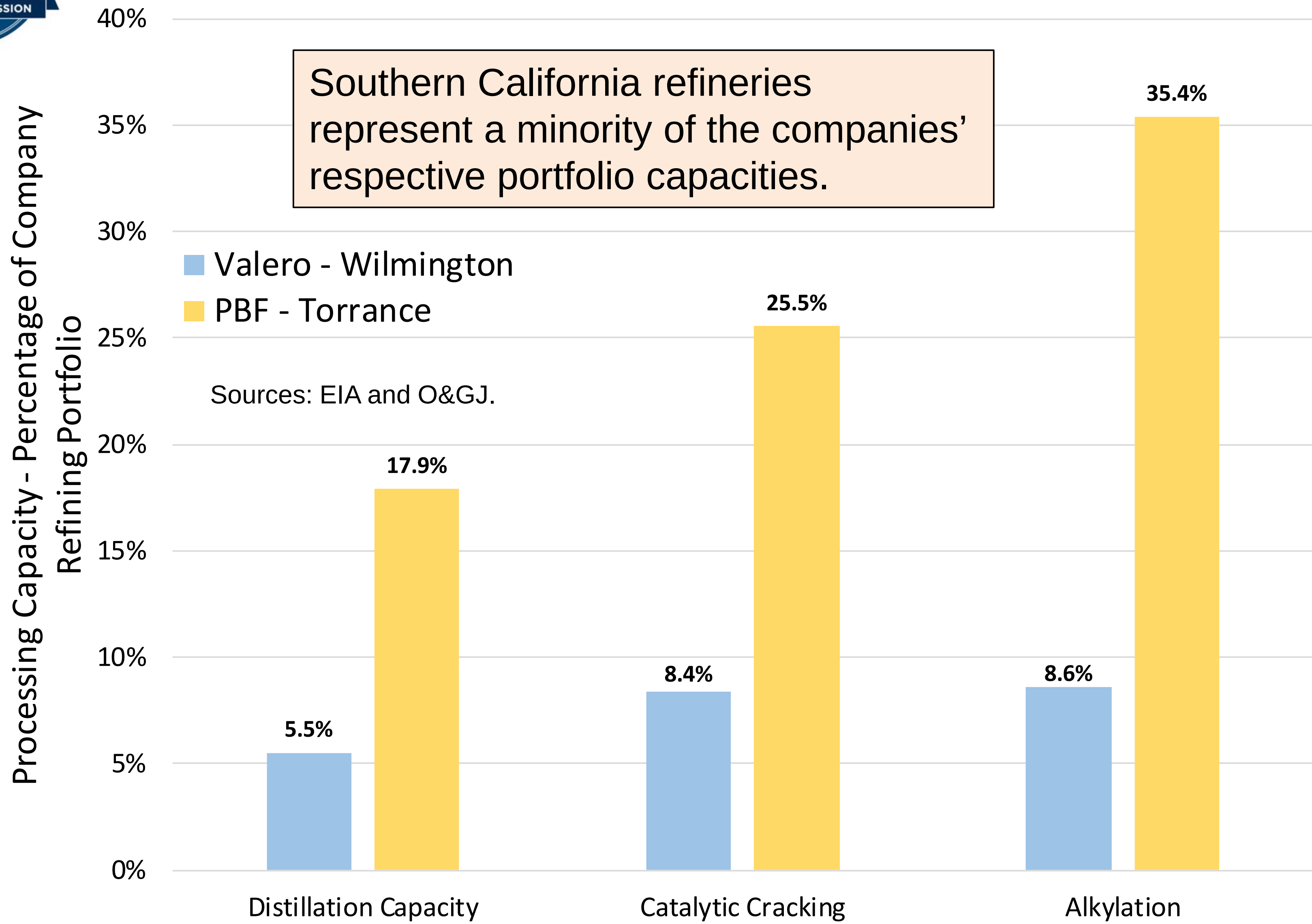


- Valero and PBF combined domestic refining assets represent 16.5 percent of U.S. crude oil processing capacity as of January 1, 2017
  - 18.7 percent catalytic cracking
  - 18.5 percent alkylation
- Valero Energy operates 15 refineries in the U.S., Canada and United Kingdom
  - 2.63 million barrels per day crude processing capacity according to Energy Information Administration (EIA) and Oil & Gas Journal (O&GJ)
- PBF Energy operates 5 refineries in the United States
  - 0.84 million barrels per day crude processing capacity according to EIA

Refining Capacity – Selected Processes



Southern California Portion of Portfolio



Capital for Refining Projects

Capital Expenditures – Petroleum Industry

WHERE FUNDS WILL GO FOR US PROJECTS Table 1

	2017 million $	2017-16 change,%	2016 million $	2016-15 change,%	2015 million $
Exploration-production					
Drilling-exploration	102,000	37.8	74,000	-39.5	122,220
Production	19,380	37.8	14,060	-39.5	23,222
OCS lease bonus	200	12.4	178	-68.3	561
Subtotal	**121,580**	**37.8**	**88,238**	**-39.6**	**146,003**
Other					
Refining and Marketing	13,200	0.8	13,100	-3.1	13,520
Petrochemicals	8,100	5.2	7,700	14.6	6,720
Crude and products pipelines	2,327	-89.5	22,130	190.3	7,624
Natural gas pipelines	7,685	18.7	6,475	94.0	3,338
Other transportation	3,600	2.9	3,500	10.7	3,163
Miscellaneous	3,000	25.0	2,400	-37.5	3,840
Subtotal	**37,911**	**-31.5**	**55,305**	**44.8**	**38,206**
Total	**159,491**	**11.1**	**143,543**	**-22.1**	**184,209**

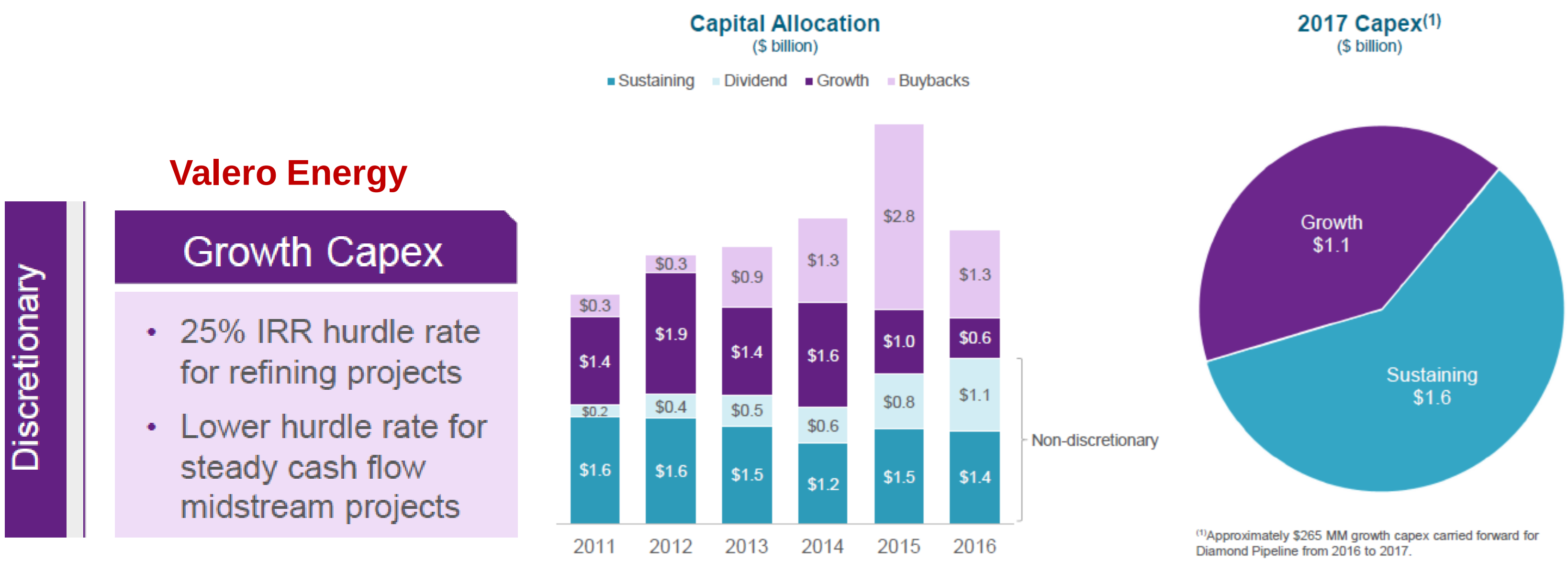
Source: Oil & Gas Journal.

- Majority of capital expenditures for U.S. projects go to upstream activities
  - 79.3 percent in 2015, 61.5 percent in 2016 & 76.2 percent for 2017
- Only a small portion usually goes towards refining and marketing projects
  - 7.3 percent in 2015, 9.1 percent in 2016 & 8.3 percent for 2017

Investment Decisions & Approved Projects

Capital Approval for Projects

- Refining companies have specific guidance for capital expenditures
  - Non-discretionary (Maintenance & dividends)
  - Discretionary (Projects, acquisitions & stock buy-backs)
  - Limits of total capital expenditures (CAPEX)



Source: Valero Investor Relations Presentation – September 2017.

Recent Valero Discretionary Projects & IRRs

- Meraux refinery hydrocracker conversion
  - $260 million, 25 percent unlevered IRR at 2014 prices
  - Operational December 2014
- McKee refinery diesel recovery improvement and crude unit expansion
  - $160 million, 45 percent unlevered IRR at 2014 prices
  - Completed in 2015
- Corpus Christi and Houston refinery light topping expansion projects to handle greater quantities of lighter crude oils – 160 KBD additional processing capacity
  - $750 million, 50 percent unlevered IRR at 2014 prices
  - Corpus Christi work completed in 2015

Likelihood of Alkylation Replacement

Alkylation Replacement Costs

- If an HF ban were compelled it is unlikely either or both companies would elect to make such changes to their facilities
  - Alkylation process unit projects are extremely expensive
    - A recent project approved for the Valero Houston refinery is estimated to cost $300 million for an alkylation unit with a capacity of 13,000 barrel per calendar day
    - Capacity of the alkylation units at Valero Wilmington and PBF Torrance are 22,000 and 24,200 barrels per day capacity, respectively
    - These alkylation unit capacities are each nearly twice the capacity, meaning the potential costs for such projects at the two California refineries could, at a minimum, easily approach or exceed $500 million *per facility* – excludes spent acid regeneration
    - Burns & McDonnell estimated $600 million for Torrance facility, additional $300 for spent acid regeneration capacity
  - These estimated costs for such a replacement project could be near or exceeding the value of the refinery when one considers that ExxonMobil sold the entire Torrance refinery to PBF Energy for $537.5 million

Capital & Business Logic

- You own a mid-size car with financing payments for another three years
  - Would a bank loan you money to replace your *working* transmission that amounted to a sum greater than the value of your vehicle? – Probably not
- You own a 3 bedroom home with 20 years remaining on your mortgage
  - Would a mortgage company loan you money to replace your *working* HVAC system that amounted to a sum greater than the assessed value of your home? – Probably not
- You own a complex refinery in Southern California
  - Would a board of directors agree to commit discretionary capital to replace your *working* alkylation process unit that amounted to a sum greater than the resale value of your entire refinery and had a negative IRR? – Probably not

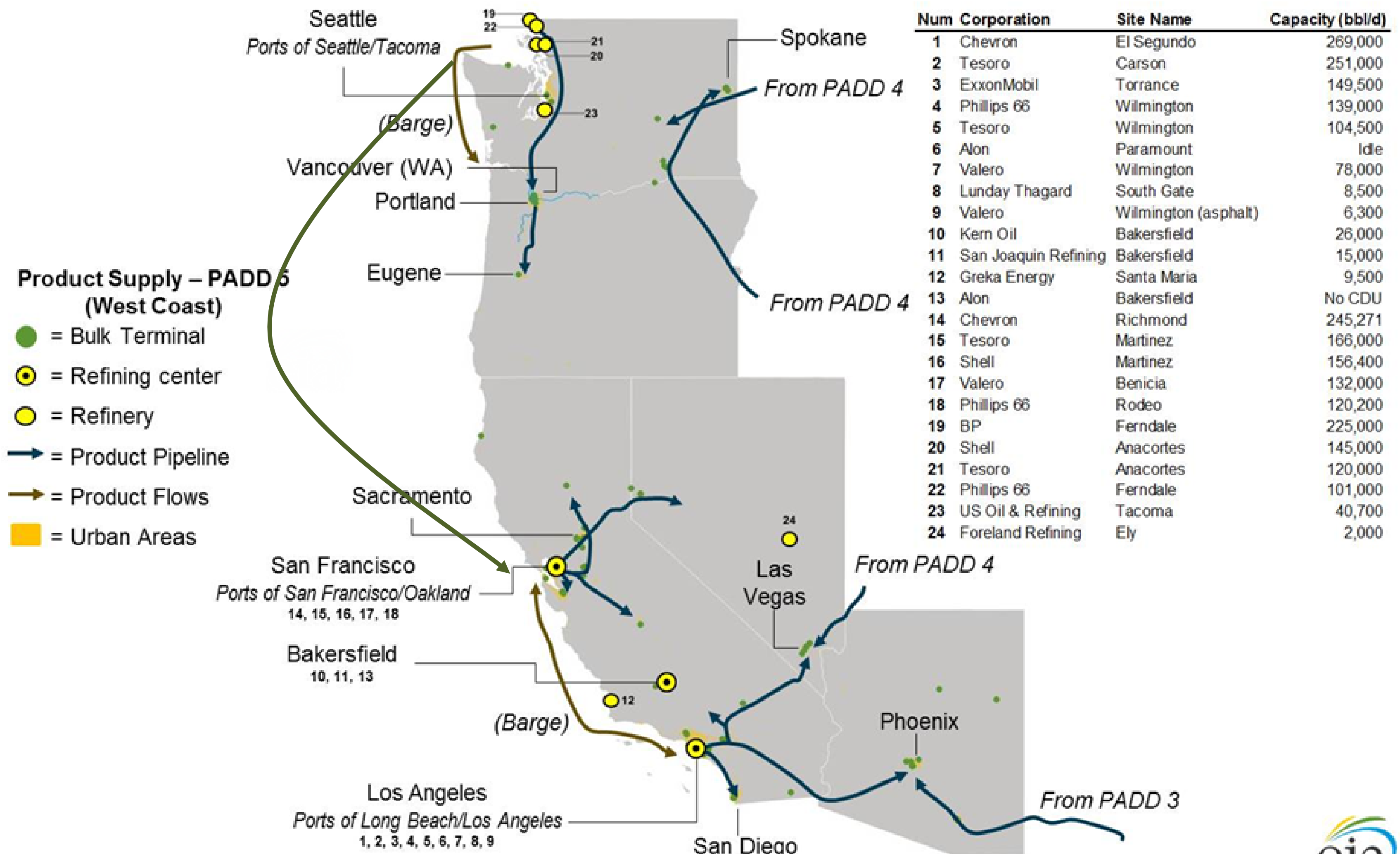
Likelihood of Alkylation Replacement

- It goes against sound business principles that the Valero and PBF board of directors would agree to spend an amount of capital on two refinery assets that would be greater than the valuation of the facilities and would incur a negative IRR
- Conclusion – if the HF ban is approved, the two Southern California refineries would likely cease operations some time prior to the effective deadline
- Therefore the particulars regarding the amount of time necessary to obtain all permits, complete engineering, demolish the existing alkylation units, and construct the new process units would be less relevant

Refinery Closure Implications – Regional Supply

Western States More Isolated than Rest of U.S.

West Coast petroleum product supply map



Num	Corporation	Site Name	Capacity (bbl/d)
1	Chevron	El Segundo	269,000
2	Tesoro	Carson	251,000
3	ExxonMobil	Torrance	149,500
4	Phillips 66	Wilmington	139,000
5	Tesoro	Wilmington	104,500
6	Alon	Paramount	Idle
7	Valero	Wilmington	78,000
8	Lunday Thagard	South Gate	8,500
9	Valero	Wilmington (asphalt)	6,300
10	Kern Oil	Bakersfield	26,000
11	San Joaquin Refining	Bakersfield	15,000
12	Greka Energy	Santa Maria	9,500
13	Alon	Bakersfield	No CDU
14	Chevron	Richmond	245,271
15	Tesoro	Martinez	166,000
16	Shell	Martinez	156,400
17	Valero	Benicia	132,000
18	Phillips 66	Rodeo	120,200
19	BP	Ferndale	225,000
20	Shell	Anacortes	145,000
21	Tesoro	Anacortes	120,000
22	Phillips 66	Ferndale	101,000
23	US Oil & Refining	Tacoma	40,700
24	Foreland Refining	Ely	2,000

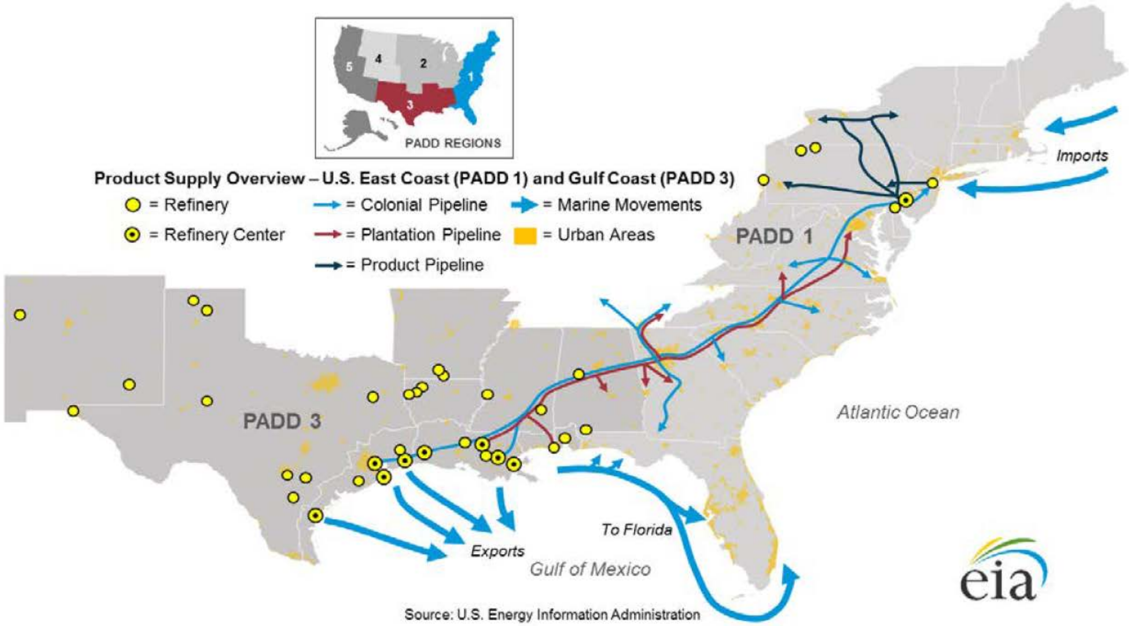
Source: U.S. Energy Information Administration.

California Fuels Market - Isolated

- California's market is nearly self-sufficient, so supplies of gasoline and diesel fuel from outside of California are not routinely needed to balance out supply with demand
  - Imports of gasoline and blending components account for only 3 to 6 percent of supply
- The California market is geographically isolated from other locations in the United States that produce refined products
- Pipelines connect California refining centers to distribution terminals in Nevada and Arizona, but these pipelines only operate in one direction – sending gasoline and other transportation fuels to these neighboring states
- California market is isolated by time and distance from alternative sources of re-supply during unplanned refinery outages

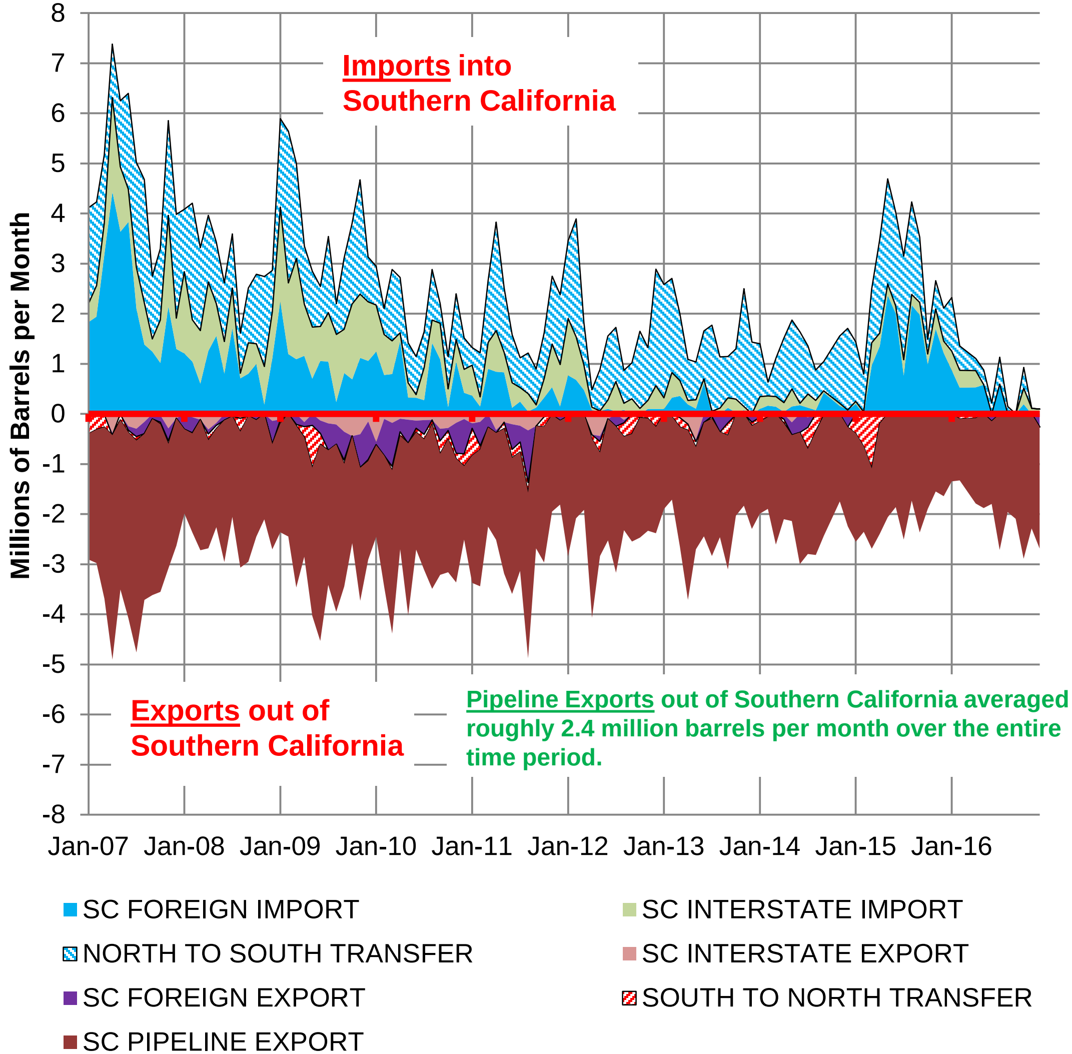
Balance of Other Regions Varies

- U.S. Gulf Coast (PADD 3) large net ***exporting*** region
  - During 2014, region consumed an average of 2.5 million barrels per day (b/d) of transportation fuels yet produced 7.5 million b/d
- U.S. East Coast (PADD 1) large net ***importing*** region
  - During 2014, region consumed an average of 4.9 million b/d of transportation fuels but only produced 1.0 million b/d, representing 20 percent of the region's supply



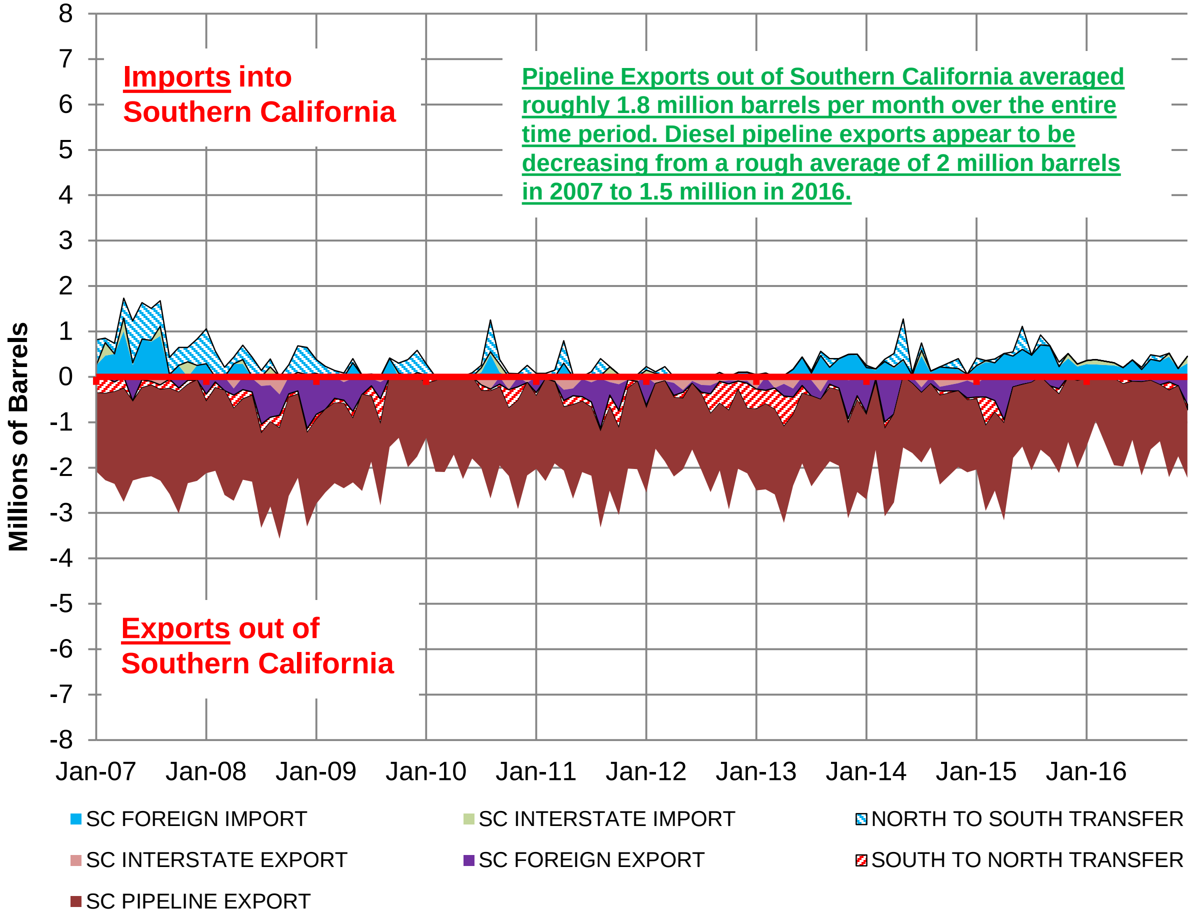
Gasolines Flows – Southern California

- Net importer via marine
- Usually close to balance
- Foreign imports when needed & economic
- Domestic imports rare
- Imports from N. Calif. normal portion of their supply – volumes fluctuate based on refinery outages
- Pipeline exports to NV & AZ
  - 5 times N. Calif. volumes
- Foreign exports minimal
- Domestic exports eliminated
- Exports to N. Calif. rare – volumes fluctuate based on refinery outages



Source: California Energy Commission

Diesel Flows – Southern California



Source: California Energy Commission

- Large net exporter
- Foreign imports when needed & economic
- Domestic imports rare
- Imports from N. Calif. Related to refinery outages
- Pipeline exports to NV & AZ
  - 3 times N. Calif. volumes
- Foreign exports declined
- Domestic exports eliminated
- Exports to N. Calif. rare – volumes fluctuate based on refinery outages

Loss of Refining Capacity Impacts Markets – Historical Example

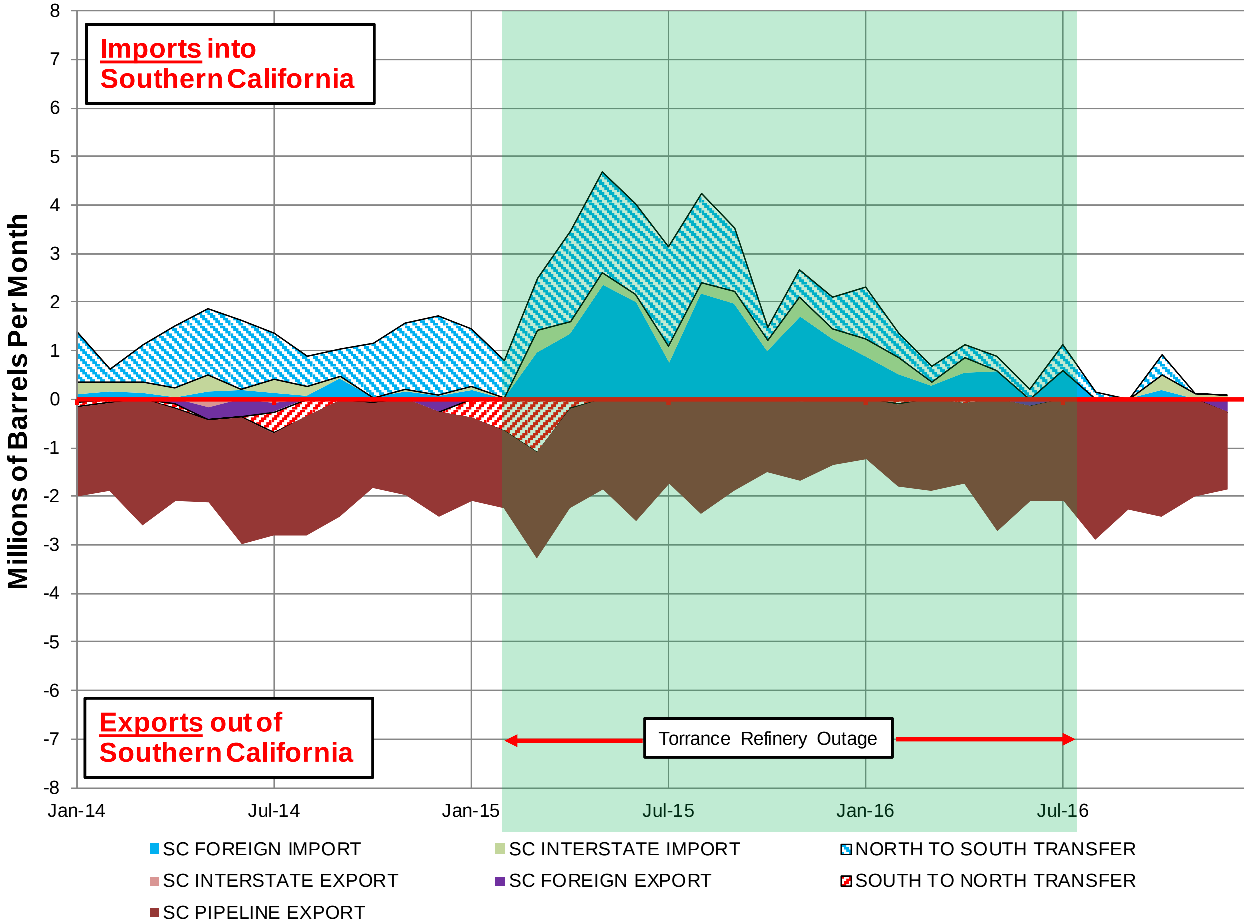
- The Torrance ESP explosion and subsequent inability of ExxonMobil to operate their primary gasoline-producing process equipment for 17 months necessitated a rebalancing of the transportation fuels market for West Coast
  - Decreased local supply had to be replaced by combination of increased imports from outside the region and decreased shipments to Nevada and Arizona

		2014		2015		Change
Demand (MBPD)						
	Domestic	1543		1575		32
	Export	55		42		(13)
	Total	1598		1617		19
Supply (MBPD)						
	Production	1410		1345		(65)
	From PADD 3	130		145		15
	From PADD 4	42		50		8
	Inventory	(4)		15		19
	Imports	21		62		41
	Total	1598		1617		19

Source: Energy Information Administration.

Shortfall	
Demand	32
Production	65
Total	97
Makeup	
Imports	41
Inventory	19
PADD 3	15
Exports	13
PADD 4	8
Total	97

Gasoline Market – ESP Explosion



Source: California Energy Commission

- 2015 vs. 2014 Changes March thru December

  Marine imports jump
  - Foreign imports increased by 14.1 million barrels or 46.1 KBD
  - Washington imports increased by 1.4 million barrels or 4.5 KBD
  - N. Cal. transfers increased by 2.5 million barrels or 8.3 KBD

  Pipeline exports decline
  - Arizona exports declined by 1.2 million barrels or 4.1 KBD
  - Las Vegas exports droped by 1.4 million barrels or 4.4 KBD

Regional Supply Impacts – Valero & PBF Refinery Closures

Stillwater Associates performed a detailed assessment

Stillwater Associates LLC

1. Loss of 225 KBD of G+D production represents about 25% of regional demand
2. Finished gasoline production will be 153 KBD lower and require foreign imports
3. Jet fuel production will be 26 KBD lower and require foreign imports
4. Diesel production will be 46 KBD lower and require some foreign imports
5. Estimate 140 KBD of domestic crude production will need to find a new home

Thousand Barrels /Day	Base	Refinery Shutdown	Net Change
Refinery Input			
Crude - Domestic	140	0	(140)
Crude - Foreign	60	0	(60)
Imported FCC Feed	32	0	(32)
Imported Alkylate	1	0	(1)
LPG/Other	17	0	(17)
Total Input	**250**	**0**	**(250)**
Refinery Production			
Alky Feed	0	0	0
Gasoline	153	0	(153)
Jet Fuel	26	0	(26)
Diesel	46	0	(46)
LPG/Other	12	0	(12)
Total Liquid Products	**237**	**0**	**(237)**
Memo: Total G+J+D	**225**	**0**	**(225)**

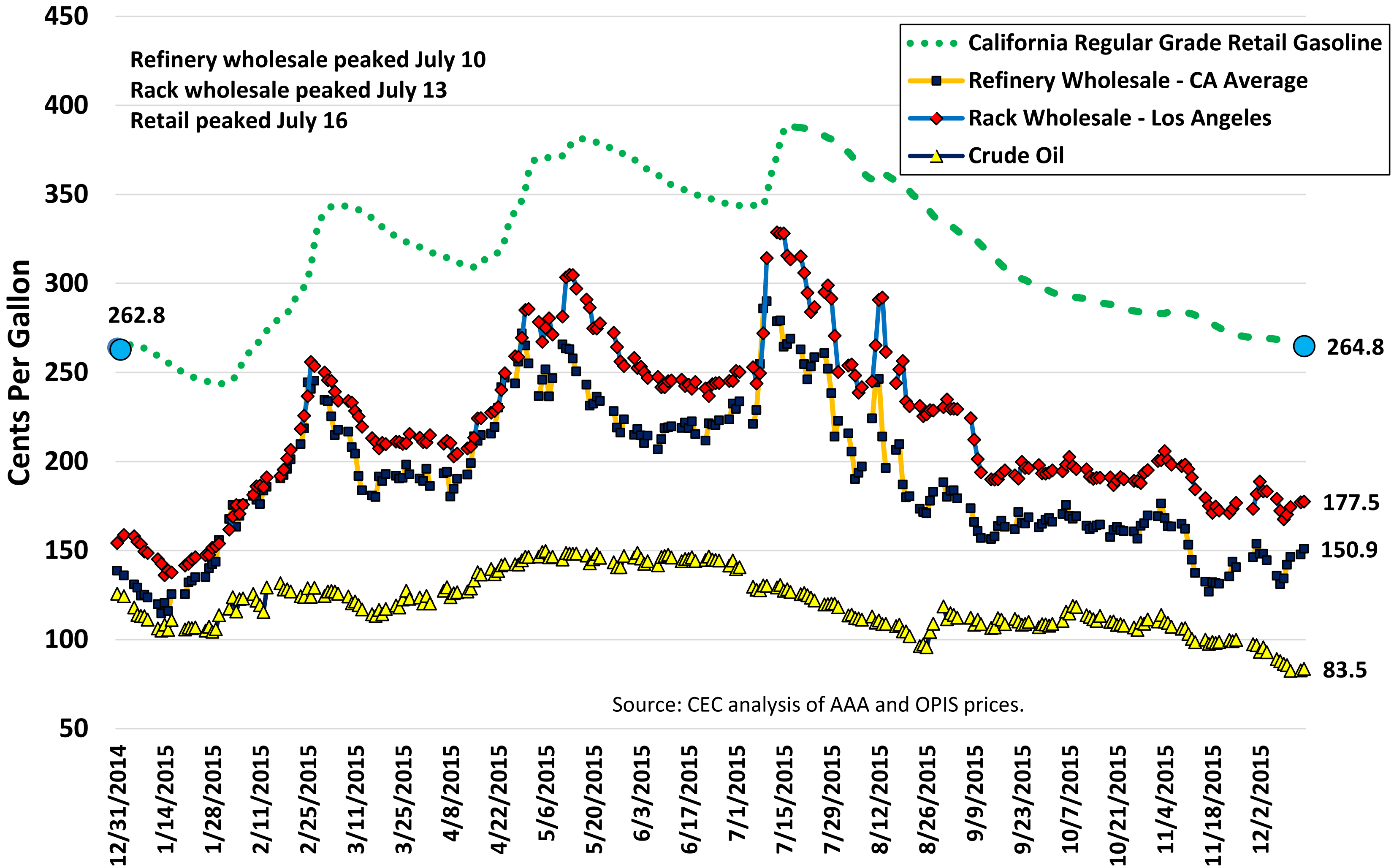
Source: Stillwater analysis

Impact of an HF Ban on Southern California Transportation Fuels Supply, June 23, 2017

Supply impacts of two refineries being closed down expected to be greater in magnitude, of longer duration, and higher in costs to motorists and truckers than those resulting from the temporary loss of gasoline production capability at Torrance refinery following the ESP explosion on 2/18/15

Refinery Closure Implications – Fuel Prices

California Gasoline Price Changes
Retail, Rack and Refinery Wholesale



HF Ban – Fuel Price Implications

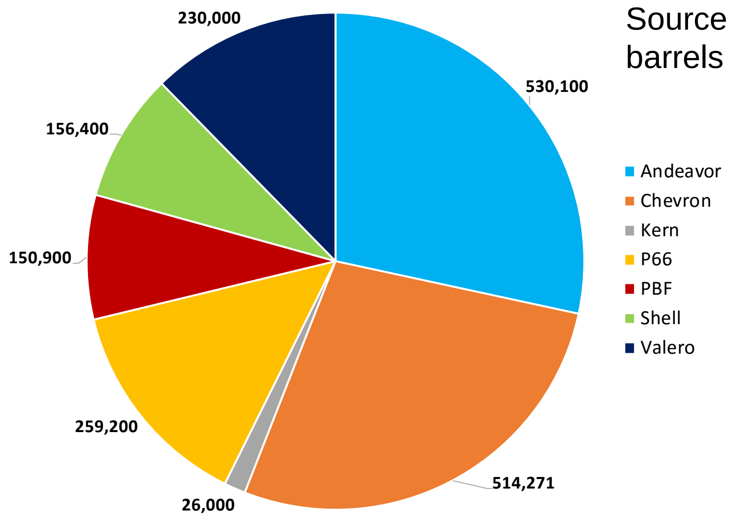
- Permanent loss of process units primarily creating gasoline blending components (catalytic cracking & alkylation) would be 60.4 percent greater than the temporary loss associated with the Torrance outage
  - 207.9 KBD versus 129.6 KBD
- Incremental impacts on gasoline costs for consumers and businesses could be as bad or worse than those of experienced for the duration that the Torrance ESP was out of operation
  - Gasoline prices averaged 26 cents per gallon greater than normal for 17 months
  - Equates to incremental costs of $5.6 billion for motorists & businesses
- Closure of two refineries would also increase prices for diesel and jet fuel

Refinery Closure Implications – Competition

Crude Oil Processing Capacity - Statewide

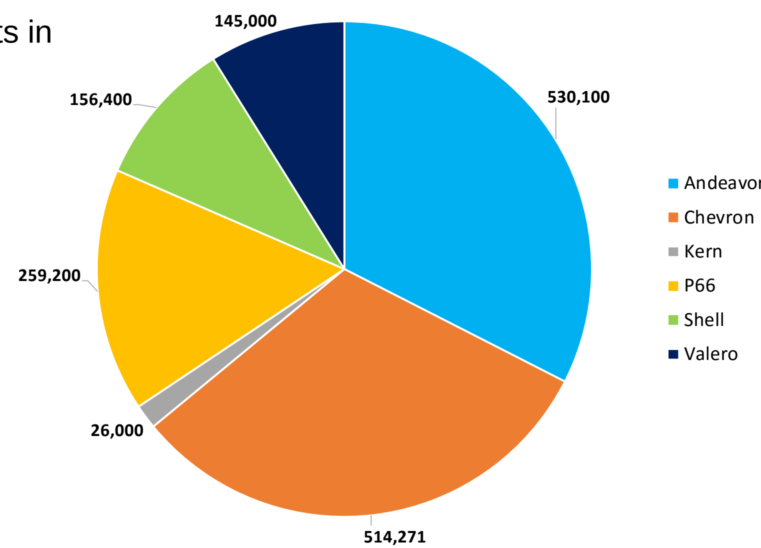
- California crude oil processing capacity would be more concentrated by refinery ownership post closure of Valero Wilmington and PBF Torrance

Current



Source: EIA. Units in barrels per day.

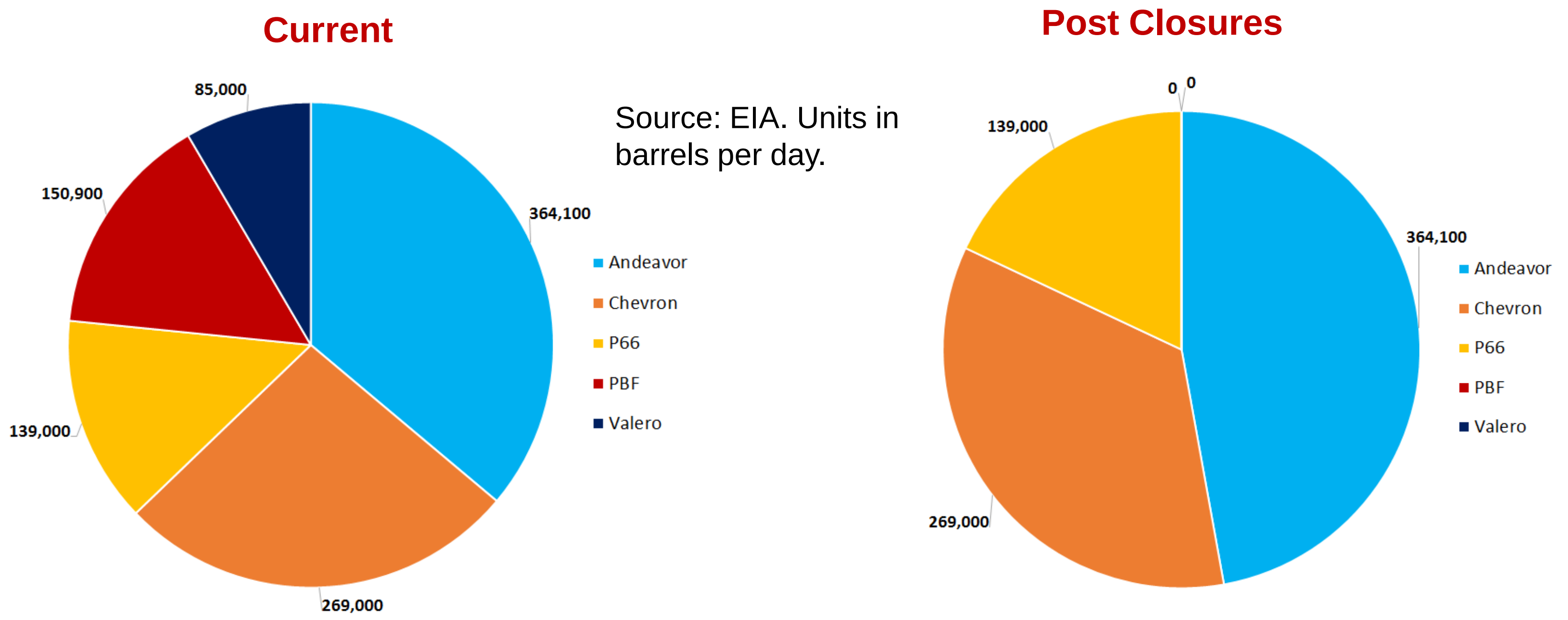
Post Closures



Portion operated by Andeavor, Chevron & P66 would rise from 69.8 to 79.9 percent of total.

Crude Oil Processing Capacity – S. Calif.

- Southern California crude oil processing capacity would be more concentrated by refinery ownership post closure of Valero Wilmington and PBF Torrance

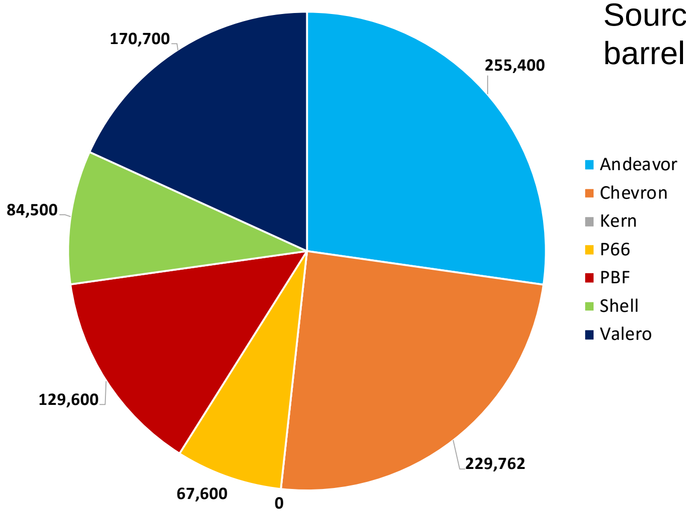


Portion operated by Andeavor & Chevron would rise from 62.8 to 82.0 percent of total.

Gasoline-Related Process Capacity - Statewide

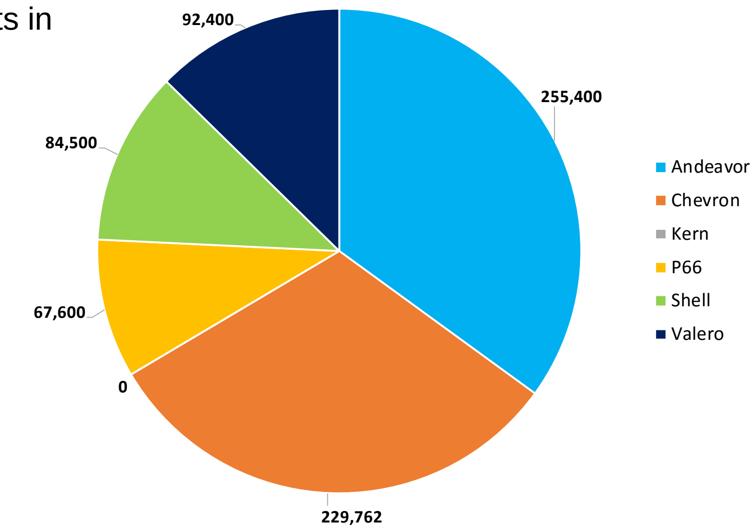
- California catalytic cracking & alkylation processing capacity would also be more concentrated by refinery ownership post closure of Valero Wilmington and PBF Torrance

Current



Source: EIA. Units in barrels per day.

Post Closures

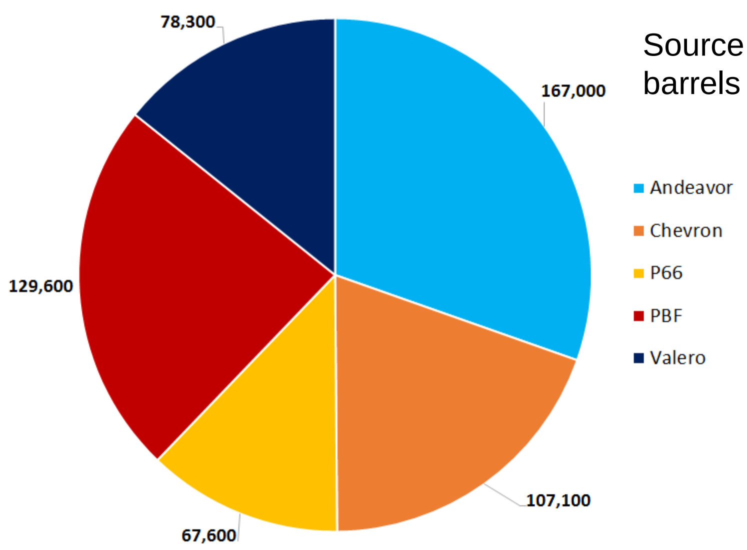


Portion operated by Andeavor, Chevron & P66 would rise from 59.0 to 75.8 percent of total.

Gasoline-Related Process Capacity – S. Calif.

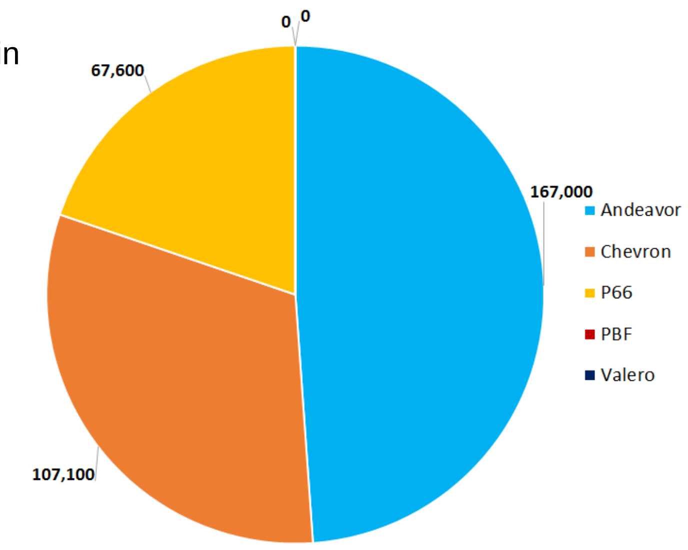
- Southern California catalytic cracking & alkylation processing capacity would also be more concentrated by refinery ownership post closure of Valero Wilmington and PBF Torrance

Current



Source: EIA. Units in barrels per day.

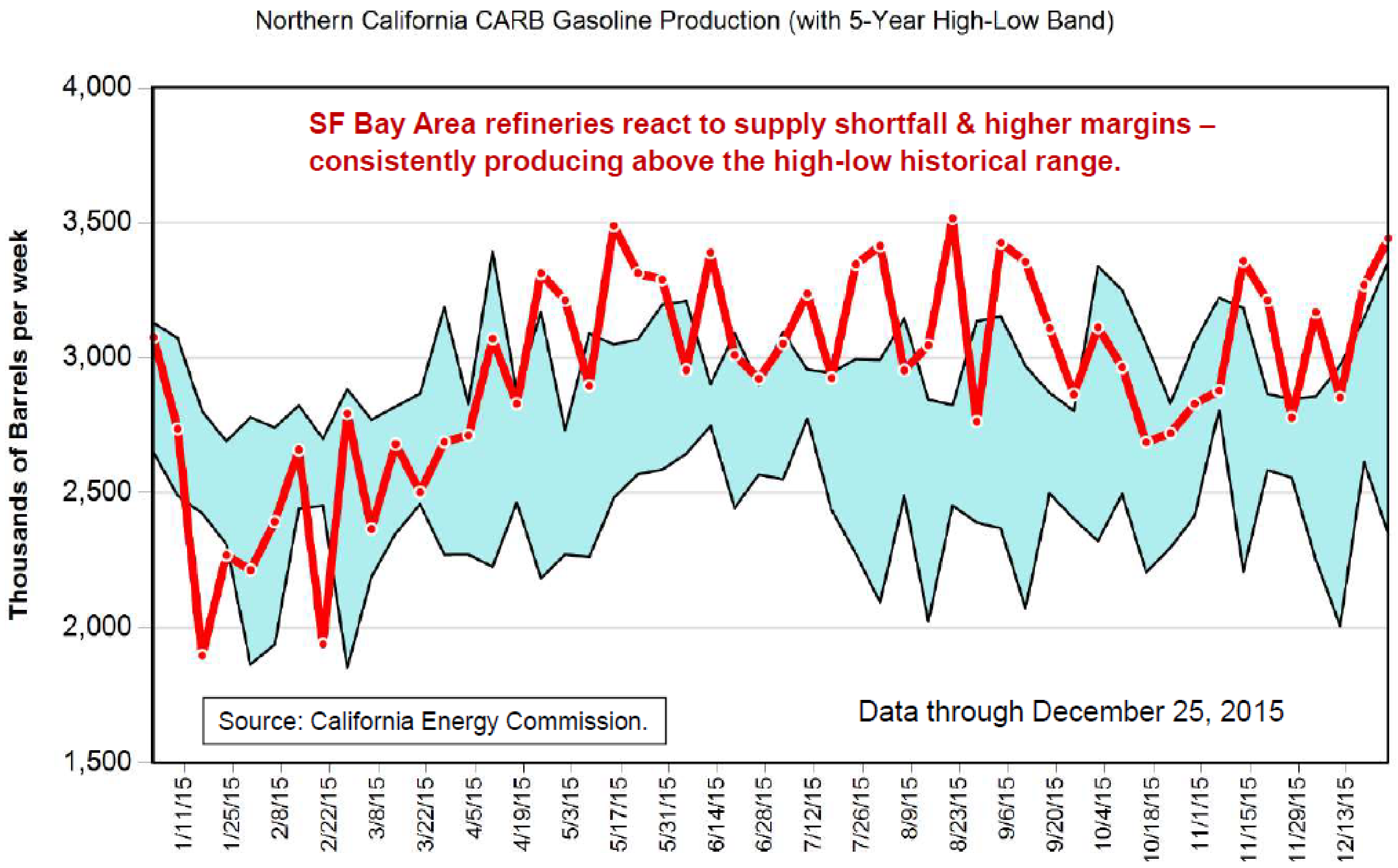
Post Closures



Portion operated by Andeavor & Chevron would rise from 49.9 to 80.2 percent of total.

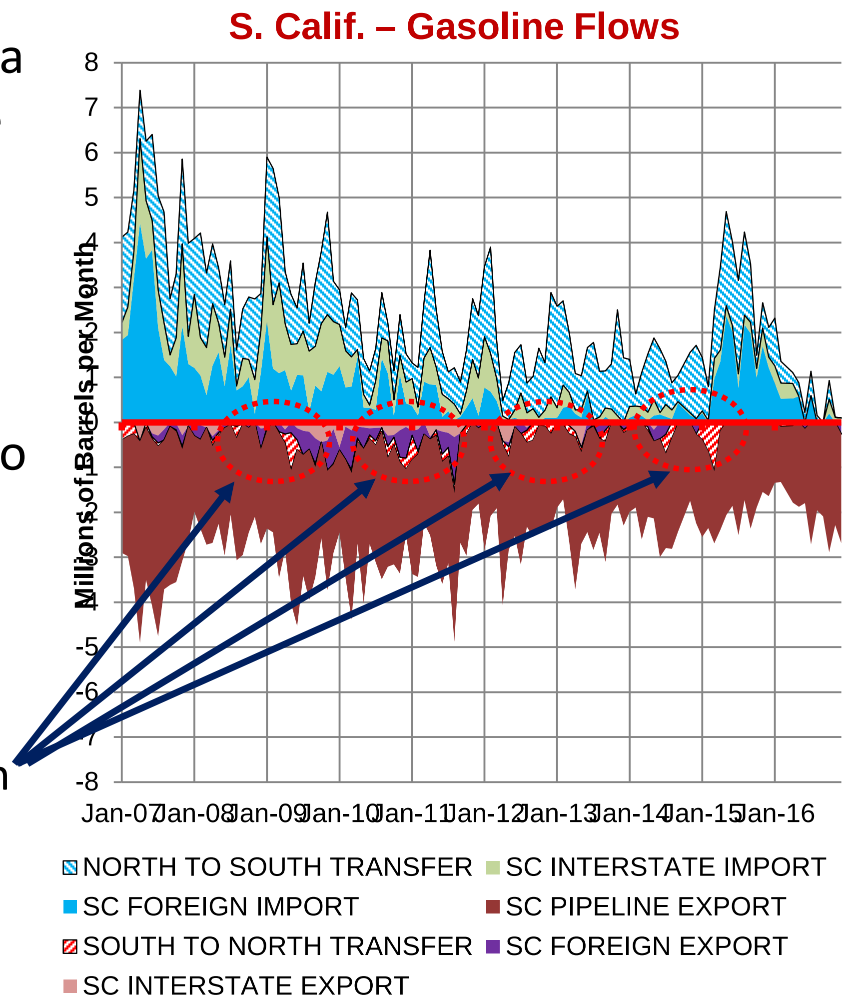
Refinery Closure Implications – Contingency Planning

Refiners – Surge Production Capability



Loss of Excess Refining Capacity

- Closure of two Southern California refineries will decrease statewide refining surge capacity
- Ability of remaining Southern California refineries to ramp up refinery output will be greatly diminished as region transitions to a significant net importer of gasoline and other refined petroleum products
  - Will decrease ability to send supplies to Northern California in response to:
    - Significant unplanned refinery outages
    - Catastrophic earthquake in the greater San Francisco Bay Area



Additional Q & A

Del Amo oil field in southern Torrance, circa 1938 – Daily Breeze.

Circa 2014 - LA-Curbed & Google Earth.

OPINION

Proposed SCAQMD rule will kill high-paying jobs, hike gas prices: Blanca Rubio

AP Photo/Reed Saxon

The refinery in Torrance, Calif., Monday, Oct. 8, 2012.

By **BLANCA RUBIO** |
PUBLISHED: February 20, 2018 at 6:30 pm | UPDATED: February 20, 2018 at 10:33 pm

0 COMMENTS

California's working families are too often left out of the conversation on policies that deeply impact them. One policy that would have far-reaching consequences on fuel supply and prices is South Coast Air Quality Management District proposed Rule 1410, which would ban the use of modified hydrofluoric acid at California refineries. This proposed rule is currently being pushed at the AQMD by a handful of activists whose previous attempts at a ban have died or stalled out at the Torrance City Council and in the state legislature.

Simply put, this proposal would mean families will pay more at the pump. A recent analysis by the California Energy Commission found that it runs the likely risk of shutting down two Southern California refineries that are responsible for 25 percent of Southern California's fuel supply. The proposal would also eliminate hundreds of good paying, blue and white collar jobs for residents of our region at a time when California's unemployment rate exceeds the nation.

And what does this policy mean for consumers? We could soon be paying 26 cents or more per gallon of gas as a result of this proposal, driving up costs by billions of dollars for Southern California commuters.

In the face of these staggering economic findings from the California Energy Commission, those pushing for proposed Rule 1410 at the Sept. 29 AQMD working group meeting have admitted that, "if there is an uptick [in gas prices], certainly that would be a burden on low income families." But, these same activists claim higher prices would have the positive effect of reducing traffic by making it more unaffordable to drive. They also claim these dramatic price increases would "be just taken in stride" by California working families.

Taken in stride? I disagree. My constituents and all of California's hard-working, low-income families already disproportionately pay for their energy needs — often more than 20 percent of their monthly budgets. Many must commute further to have an affordable place to live. This proposal would only serve to drive these costs even higher, hurting Californians who can least afford it.

New legislation just went into effect that increased the price of gasoline by 12 cents a gallon to repair California's crumbling roads while creating jobs. But now those pushing for Rule 1410 want to increase gas prices by at least 26 additional cents a gallon — and for what? To ban a chemical that is needed to produce California's clean burning fuels and has been safely used in our state for more than 50 years.

California's refineries operate under the toughest safety regulations in the nation. The state just spent nearly five years developing the nation's most stringent standards for refinery safety in collaboration with refinery workers, labor unions, community-based organizations and the public. These regulations are in place to ensure the continued safety of refinery workers and surrounding communities.

This proposal has the potential to impact not just those in the South Bay, but everyone in Southern California — hurting California's working families the most. I am confident the South Coast Air Quality Management District Governing Board will balance the need for local refineries to continue operating, while protecting safety and preventing energy price increases for consumers.

Assemblywoman Blanca Rubio, D-Baldwin Park, represents California's 48th State Assembly district.

Tags: Guest Commentary

Blanca Rubio

VIEW COMMENTS

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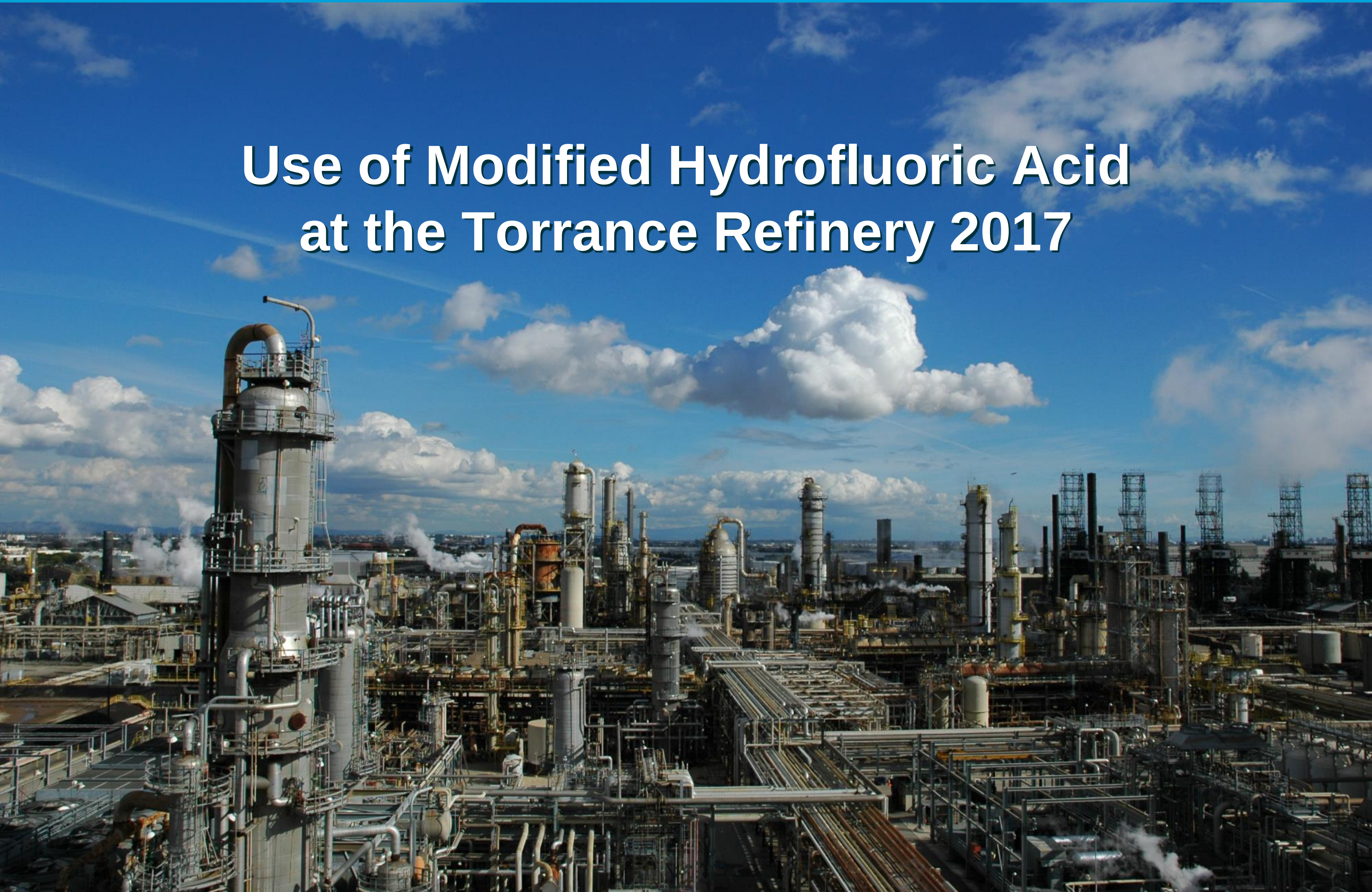
If you see comments that you find offensive, please use the “Flag as Inappropriate” feature by hovering over the right side of the post, and pulling down on the arrow that appears. Or, contact our editors by emailing moderator@scng.com.

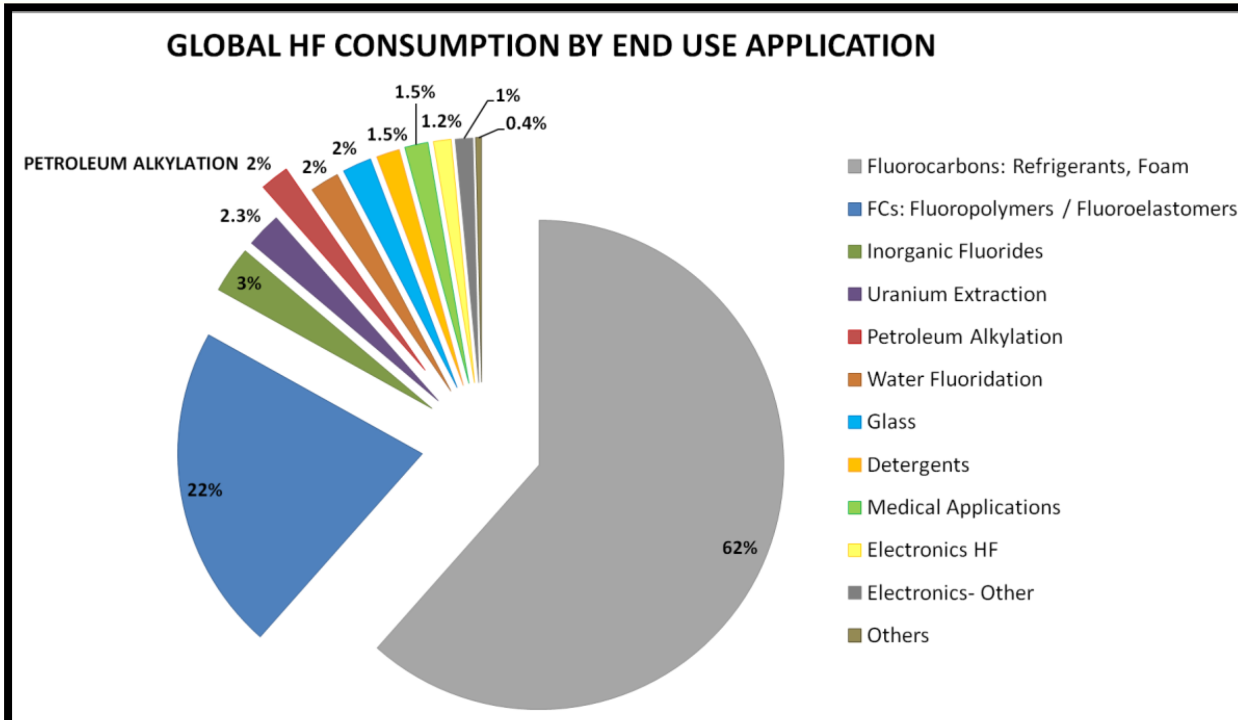
Use of Modified Hydrofluoric Acid at the Torrance Refinery 2017



INTRODUCTION

- **PBF Energy and its subsidiary Torrance Refining Company LLC, is committed to safe, reliable and environmentally responsible operation of the Torrance Refinery**
- **PBF Energy recognizes we have to earn the right to operate in the communities that host us**
  - ✓ We maintain an open dialogue with the communities in which we operate
- **PBF understands community members are concerned about the use of modified hydrofluoric (MHF) acid at Torrance**
  - ✓ Reviewed current and alternative alkylation technologies with third-party experts
  - ✓ Conclusion - only two viable technology options are currently available
    - ❑ MHF and Sulfuric Acid
- **PBF considers MHF technology to be the best fit for the Torrance Refinery**
  - ✓ We are confident the Torrance unit will operate safely with highly skilled and trained operators, use of a proprietary additive along with other mitigation measures to suppress vapors, strong procedures, and redundant safety systems and safety mitigation equipment
- **Torrance manufactures ~10% of California's cleaner-burning CARB gasoline**
  - ✓ Eliminating MHF alkylation would significantly reduce CARB gasoline production

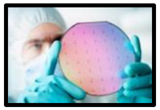
HYDROGEN FLUORIDE USES



Source: *Fluorspar Global Industry Markets and Outlook* , 11th Edition 2013, Roskill Information Services

- **HF is critical to many industrial applications**
- **Multiple California industries rely upon HF**
- **Thousands of CA residents work at sites using HF**
- **Refining alkylation represents ~2% of HF end use**

Uses in California



Semiconductors

Agricultural Products

Gasoline

Refrigerants
Buildings, car, food

Water Fluoridation

Quartz
Glass, solar

Pharmaceuticals

Brewing Beer

Household Products

WHAT IS HYDROFLUORIC ACID?

CHEMICAL PROPERTIES

- Discovered in 1771 by a pharmaceutical chemist
- Clear, colorless, corrosive, pungent liquid that requires specialized safety precautions
- Forms dense, white vapor when exposed to atmosphere
- Precursor to most fluorine compounds used in many industrial applications
- Non-flammable liquid boils at 67.2 °F

EXPOSURE RISKS

- Can cause burns - potentially toxic - inhalation hazard
  - ✓ TLV: 2 ppm (ceiling) - 0.5 ppm (TWA)
  - ✓ PEL: 0.4 ppm
  - ✓ STEL: 1 ppm (15 min)
  - ✓ IDLH: 30 ppm (30 min)
- Can reduce calcium levels in body
- Delayed onset of symptoms possible

MEDICAL TREATMENT

- Water wash
- Iced 0.13% benzalkonium chloride soaks
- Skin burns: 2.5% calcium gluconate gel
- Eyes: 1.0 % calcium gluconate in saline
- Inhalation: 2.5% calcium gluconate and oxygen

Active California RMP Participants
> 50% HF and > 1,000 pounds HF on site

Facility Name	City
Alloys Cleaning, Inc.	Los Angeles
Brenntag Pacific, Inc. Santa Fe Springs Facility	Los Angeles
Dow Agrosciences / Douglas Products	Pittsburg
Gallade Chemical, Inc. - Santa Ana (Fed Filing)	Santa Ana
Matheson Tri-Gas - Newark, CA Branch	Newark
Precision Specialty Metals, Inc.	Los Angeles
Univar USA Inc.	Commerce
Univar USA Inc.	San Jose
Valero Wilmington Refinery	Wilmington
VWR International - Visalia Distribution Center	Visalia

Source: The Right-To-Know Network, http://www.rtknet.org

Note: This list omits all California HF users that store less than 1,000 pounds on-site, as well as facilities in the state that use HF in a concentration of 49% or less

HOW IS HF USED IN PETROLEUM REFINING?

- **Oil refineries use HF as a catalyst, a substance that increases the rate of chemical reaction without undergoing any permanent chemical change itself**
  - ✓ Refineries use Anhydrous Hydrogen Fluoride or Modified Hydrogen Fluoride
- **Refineries use HF / MHF technology in the alkylation process to modify petroleum feedstocks to produce high octane “alkylate”**
- **Refineries blend alkylate with other refined hydrocarbons to make gasoline**
  - ✓ Alkylate: “blending component” required to meet strict CARB gasoline standards
    - ❑ Alkylate provides high octane ratings and possesses cleaner-burning properties, particularly important in refining gasoline sold in California
    - ❑ Each barrel of alkylate produces approximately five barrels of CARB gasoline

WHAT IS MODIFIED HYDROFLUORIC (MHF) ACID?

- **Modified Hydrofluoric Acid (MHF) is HF that contains an additive that lowers the volatility of the original compound**
  - ✓ Along with other equipment at the Torrance refinery, the additive helps reduce risk of exposure in the event of an MHF leak or spill
- **MHF users must obtain a proprietary license from the manufacturer, which considers the additive formulation and specific concentration to be trade secrets**
- **Changing the alkylation process from HF to MHF requires an investment in and installation of additional equipment**
- **Four domestic HF units have been adapted to use MHF catalyst technology**
  - Torrance and Wilmington refineries both use MHF as an alkylation catalyst
- **What is the Airborne Reduction Factor (ARF)**
  - ARF is a measure of the reduction in the amount of HF that could form a vapor cloud in the event of an incident.
  - The ARF is calculated using temperature, percent water, percent additive, and percent HF. Each of these components is important.
  - ARF monitoring results are sent to the Torrance Fire Department on a regular basis.

POTENTAL ALTERNATIVE AKYLATION TECHNOLOGIES

Alternative alkylation technologies with different properties are in various stages of development:

1. **Indirect Alkylation**
   - ✓ Uses a solid catalyst
   - ✓ Alkylate yield is 50% lower than MHF Alkylation
   - ✓ Only nine operating units; most overseas
   - ✓ Not a viable choice for California Clean Gasoline production because the lower yield reduces total gasoline production by an equal percentage

2. **Solid Catalyst Alkylation**
   - ✓ Commercially unproven
   - ✓ Rapid catalyst deactivation
   - ✓ Research focus has shifted to Ionic Liquid Alkylation

POTENTAL ALTERNATIVE AKYLATION TECHNOLOGIES

3. **Ionic Liquid Alkylation**
   - ✓ 2012: continuous pilot plant constructed
   - ✓ 2015: regeneration pilot plant commissioned
   - ✓ Engineering started for demonstration unit
   - ✓ First commercial unit expected to be online in 2020 at a refinery in Salt Lake City

- **Before PBF adopts any new alkylation catalyst, the technology must be proven to be safe, reliable, environmentally responsible, and commercially viable in a full scale application**
  - ✓ None of the new, alternative alkylation technologies has reached a mature state of technical, commercial, and economic viability

- **PBF will continue to closely monitor, and continue its dialog with the companies developing the unit in Salt Lake City**

TWO VIABLE ALKYLATION TECHNOLOGIES

- **Petroleum refineries use two distinct processes to manufacture alkylate, a critical blending component in CARB gasoline**
  - ✓ Both processes use a liquid acid catalyst to promote the desired chemical reaction
    - ❑ Hydrofluoric (HF) acid alkylation
    - ❑ Sulfuric acid alkylation
- **HF acid and sulfuric acid alkylation have similar basic chemical reactions**
  - ✓ However, process equipment and design requirements differ significantly
  - ✓ There are also differences in product quality and catalyst consumption
- **Alkylation processes and catalysts are not interchangeable - product quality differences are also an important factor**
- **Refinery configuration can also dictate which process will be more effective**
- **No U.S. refinery has ever switched alkylation units from HF to sulfuric acid**

CONSIDERATIONS ASSOCIATED WITH EACH TECHNOLOGY

- **Example: 10,000 barrel per day (BPD) sulfuric acid alkylation unit processing propylene-butylene feedstocks**
  - ✓ Requires ~225 trucks per month of “fresh” sulfuric acid supply
    - ❑ Equivalent to ~200x more fresh acid than “same size” MHF unit
  - ✓ Typically, “spent” sulfuric acid must be transported offsite to be “regenerated”
    - ❑ Shipping “spent acid” adds ~225 truckloads per month
    - ❑ 200x more volume than HF acid, which doesn’t require regeneration
  - ✓ Result: Actual amount of fresh and regenerated spent sulfuric acid shipped to / from sulfuric acid units is ~400x greater than similar-sized HF alkylation unit
- **Torrance MHF alkylation unit processes ~28,000 barrels per day (BPD)**
  - ✓ Sulfuric acid unit requires ~1,540 truck shipments/month @ ~51 trucks/day
  - ✓ The Torrance unit receives three to six shipments of MHF per month
- **Existing U.S. sulfuric acid regeneration facilities are near maximum capacity**
  - ✓ Constraint could require refiners considering sulfuric acid alkylation units to identify new sources or construct on-site regeneration facilities
  - ✓ A new regeneration facility would add greenhouse gases, NOx, and SOx emissions sources, plus other environmental considerations, as explained in more detail below

PLOT SPACE CONSIDERATION FOR NEW UNITS

- **Sulfuric acid alkylation units often require several reactors and settlers**
  - ✓ Predominant licensor's reactor system produces < 3,000 BPD of alkylate
  - ✓ Requires larger sulfuric acid alkylation units to operate multiple reactor-settler systems in parallel to produce sufficient quantities of alkylate

- **Example: 200,000 BPD refinery producing 20,000 BPD of alkylate**
  - ✓ HF alkylation unit reaction system requires five vessels
  - ✓ Typical sulfuric acid alkylation reaction system requires 18 - 21 vessels

ENVIRONMENTAL CONSIDERATIONS

- **Environmental impact from the refining process is a primary concern for industry and an important consideration in choosing alkylation technology**

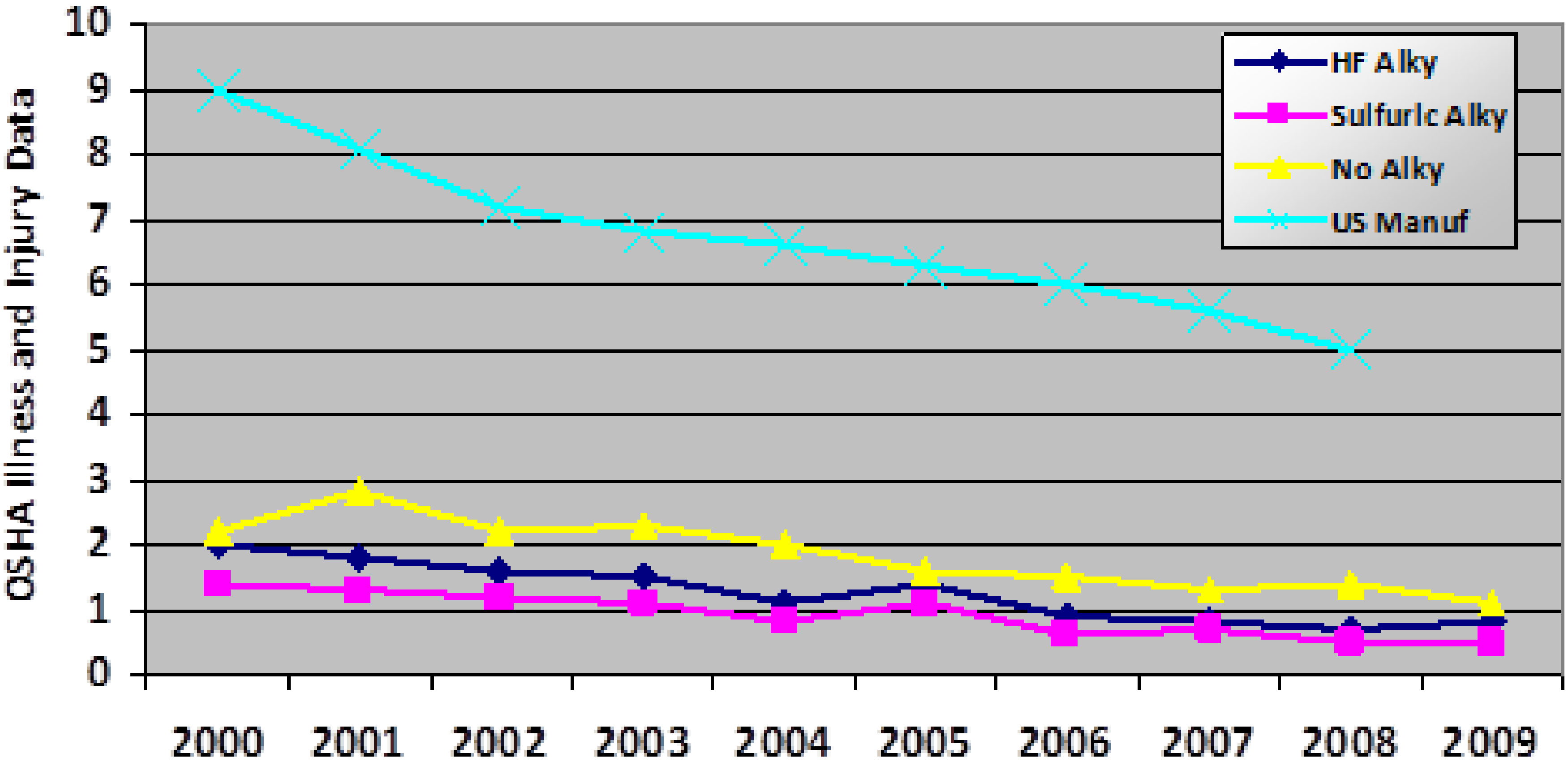
- **Primary air emission concerns are sulfur oxides, greenhouse gases (GHG), and fugitive emissions from pumps, fittings, etc.**
  - ✓ HF alkylation units consume less energy than sulfuric acid plants
    - ❑ Results in smaller GHG footprint for HF unit
    - ❑ Corresponding increase in GHG emissions for sulfuric acid plants
  - ✓ Sulfuric acid regeneration on and offsite a source of SO_2 emissions
  - ✓ Fugitive emissions from sulfuric acid alkylation could also be higher due to additional equipment required for reactor / refrigeration system

MANAGING SAFETY RISKS

- **Refiners recognize they have broad responsibility for managing risk, including safety of employees, contractors, and neighboring communities**
  - ✓ Both sulfuric acid and HF/MHF alkylation present unique risk profiles
  - ✓ The court appointed Safety Advisor for the City of Torrance determined MHF was the safest option
- **HF alkylation units benefit from 70+ years of operations and improvements**
  - ✓ Feature well-established design standards and operating and maintenance programs that fundamentally support process safety and reliability
- **Industry programs are supplemented by regulatory initiatives**
  - ✓ OSHA Process Safety Management, EPA Risk Management Program
    U.S. Coast Guard Maritime Transportation Security Act
    DHS Chemical Facility Anti-Terrorism Standards
- **Refinery safety records for employees and contractors in the U.S. indicate:**
  - ✓ Refining has personnel injury rates substantially below general manufacturing
  - ✓ Refineries with alkylation units consistently have better safety performance than facilities without them
  - ✓ Employees working at refineries with HF and sulfuric acid alkylation have similar safety performance

SAFELY MANAGING RISK

- **OSHA data indicates U.S. refineries are safer than domestic manufacturing in general**
- **Chart shows refineries with alkylation units are even safer than those without alkylation**



Source: OSHA Occupational Illness and Injury Reporting

TORRANCE MHF UNIT SAFETY MECHANISMS

- **Specialized training and emergency response drills**
- **Proprietary additive in "Modified HF" catalyst significantly reduces volatility versus conventional HF**
- **Surveillance via nine video camera systems that can be used with ten remotely-controlled "aim and shoot" water cannons to suppress MHF vapors**
  - ✓ Fixed Water Spray System & Fixed Water Monitors also suppress vapors
- **Unit shutdown, equipment isolation, rapid de-inventory system moves MHF to safe location**
  - ✓ Deluge System / Spray Curtains deploy with equipment shutdown and isolation
- **Laser Sensor system on perimeter of unit provides 360° coverage**
- **29 MHF detectors near high acid concentration equipment, unit perimeter**
- **Flange Shrouds, Settler Pans, Pump Barriers, plus protected storage drum, minimizes the potential vapor formation in the event of a release; therefore, keeping the majority of MHF in a liquid form**

TORRANCE MHF UNIT SAFETY MECHANISMS

- **Double mechanical or tandem seals for pumps in acid service**
- **Acid sensitive paint helps detect leaks on flanges**
- **Additional MHF unloading safeguards**
- **Supplier pre-mixes the additive into the catalyst before shipping**
- **Safeguarded fresh acid unloading system**
  - ✓ Can be shut down & isolated from the truck, control house, or Central Control
- **Comprehensive audits conducted by company experts, third-party consultants, and government officials**
- **Whenever a sensor detects MHF an automatic signal is sent directly to the refinery's Central Control Room and the SCAQMD office**
  - ✓ After PBF acquires the refinery we intend to electronically route the same notification signal to the Torrance Fire Department

INTENT OF EPA's RISK MANAGEMENT PLAN - RMP

- **EPA's Risk Management Plan (RMP) Rule requires facilities that store more than a threshold quantity of a regulated toxic or flammable substance in a process to develop a Risk Management Plan**
  - ✓ Plans must be revised and resubmitted to EPA every five years
- **RMP goal: to reduce potential for accidental releases that can harm the public and the environment, and mitigate severity of releases that do occur**
- **Facilities provide RMP information to local fire, police, and other emergency response personnel to help prepare for and respond to related emergencies**
- **"Worst-case analysis" uses very conservative assumptions about weather and release conditions**
  - ✓ "Distance to endpoint" estimated under worst-case conditions is intended to provide an estimate of maximum possible area that might be affected in the unlikely event of catastrophic conditions, rather than a zone in which the public might be in danger
- **EPA intends the estimated distances to provide a basis for a discussion among the regulated community, emergency planners and responders, and the public, rather than a basis for any specific predictions or actions**

Although Torrance Refinery's alkylation unit includes many layers of protection, PBF Energy's subsidiary, Torrance Refining Company, is further improving process safety by:

1. Providing a direct signal from the refinery's alkylation unit MHF leak sensors to the Torrance Fire Department
   i. SCAQMD already has this feature
2. Evaluating potential changes to the water spray systems
3. Conducting and upgrading MHF training for employees & emergency responders

PATH FORWARD

PBF continues to look for proven technologies that can improve the health and safety of employees and the community, minimize environmental impacts of refineries, and increase operational reliability. PBF plans to:

- **Continue researching alternatives to MHF**
- **Work cooperatively with employees, labor unions, and emergency responders on education and training for the Torrance MHF unit**
  - ✓ Continue to work with employees to promote effective process safety management programs based on rigorous hazard identification and mitigation
- **Reach out to stakeholders and have an open dialogue with them about the Torrance refinery, MHF, and existing emergency response management and mitigation tools, including those available in the community**

CONCLUSIONS

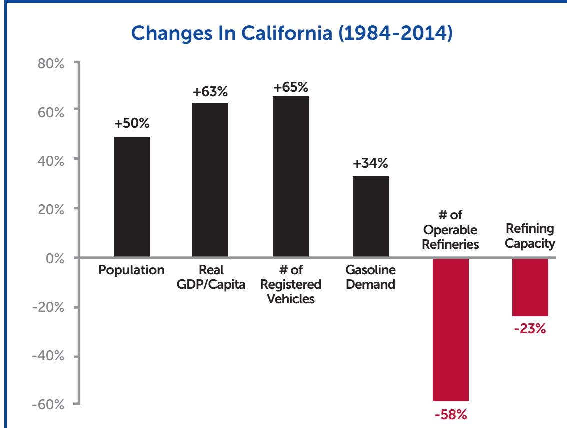
- **Along with Torrance, PBF safely operates HF Alkylation units at our Paulsboro, NJ and Chalmette, LA Refineries**
- **No emerging alkylation technology has reached the mature state of technological, economic, or commercial viability achieved by MHF or sulfuric acid alkylation**
- **Modified Hydrofluoric Acid Alkylation with current safety systems is the best and safest alkylation process for Torrance Refinery**
  - ✓ The refinery is not economically viable without this unit
- **We are confident the refinery's many layers of protection, mitigation steps, and safety systems will allow us to operate the MHF Alkylation Unit safely and reliably**

Modified Hydrofluoric Acid (MHF) Use in the Torrance Refinery

Eliminating Modified Hydrofluoric Acid (MHF) would require the Torrance Refinery, which supplies 20% of Southern California's gasoline and 10% statewide, to initiate a project that would take several years to complete. That threatens the viability of the plant and over 600 jobs, including USW, IBEW and Building Trades contractors, without any benefit or reduction in risk to the community and is expected to cost in excess of $600 million.

California has the most stringent gasoline regulations in the world. California produces almost all the gasoline sold in the state due to the lack of pipelines connecting to other states and only certain refineries outside the state being able to produce California-grade gasoline.

California: More People, More Vehicles, More Demand . . . Less Capacity



Sources: EIA; USDOT; USDA; JTC–Forbs Contributor Jude Clemente

Commitment to Safe, Reliable and Environmentally Responsible Operation

PBF Energy, through its subsidiary Torrance Refining Company LLC, owns and operates the Torrance Refinery, which uses modified HF (MHF) in the refining process to meet California clean burning fuel requirements. MHF contains an additive, which along with other safety measures, reduces the risk of the material as compared to regular HF. Only four refineries in the country have been equipped to utilize this safer form of MHF including the Torrance Refinery. The Torrance alkylation unit is one of the most advanced and sophisticated units in the world.

HF has been in use since it was discovered in 1771.

Maximizing Safety

The Torrance Refinery MHF unit has many layers of protection and we are confident in its ability to protect our employees and the community. Following our acquisition, we initiated our plan to further enhance the process and improve the safety of the unit by installing a direct signal from our monitors to the Torrance Fire Department. In addition, we have retained an independent expert to review and update our safety systems.

The many safety, monitoring and mitigation measures used in the Torrance facility are audited and inspected by independent third parties, as well as federal, state and local agencies. These measures include:

- Surveillance by 8 video camera systems that can be used with 9 remotely operated water cannons to suppress potential MHF vapors.
- Fixed water system in addition to the 9 remotely operated water cannons.
- A rapid evacuation system that quickly empties the acid into isolated containment anytime there is a threat to the unit.
- 29 MHF detectors throughout the unit as well as laser sensor monitors that provide 360 degrees of coverage of the MHF unit at all times.
- Acid sensitive paint on equipment within the unit that detects leaks.
- 3 types of physical barriers plus a protected storage drum.
- 24/7 monitoring and inspection by highly trained operators.

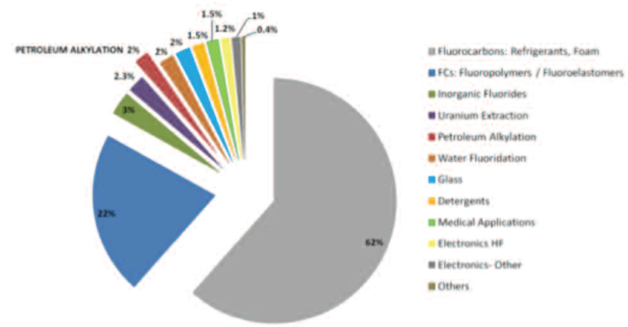
The Torrance Refinery provides 20% of southern California's gasoline, which is threatened by the elimination of MHF.

Alternatives to MHF

PBF has worked with third party experts to evaluate the continued use of MHF and found that it is the only viable option at this time. In the past, ***a court-appointed safety expert determined that the use of MHF is safer than any alternative***. The only other proven potential alternative is sulfuric acid alkylation, which poses separate risks and disadvantages:

- Sulfuric Acid alkylation requires 200 times more fresh acid.
- Sulfuric Acid does not regenerate like MHF so it has to be transported offsite for regeneration.
- The significant demand for fresh acid and the transport of spent acid would require an additional 1,450 shipments of fresh acid per month (incoming and outgoing) by truck at the Torrance Refinery.
- The regeneration of sulfuric acid requires additional equipment and can result in additional NOx, SOx, and GHG emissions.
- Under the current regulatory environment, it would take several years to permit, design and construct a sulfuric acid alkylation unit. No refinery has ever switched from one form of acid for alkylation to another.
- Based on comparable projects elsewhere, building a Sulfuric Acid Alkylation Unit at Torrance is expected to cost in excess of $600 million.

Global HF Consumption by End Use Application



Source: Fluorspar Global Industry Markets and Outlook, 11th Edition 2013, Roskill Information Services

Community Interaction

PBF respects the community's concerns about the use of MHF. PBF has met with elected officials and concerned citizens and will continue to maintain an open dialogue with our neighbors.

PBF and the community have a common goal of wanting the refinery to operate safely. We are confident in the systems that we have in place. We continually follow technology to identify ways to advance our operations.

Emerging Technology

A new technology—Ionic Liquids Alkylation—is being evaluated at a refinery in Salt Lake City. That unit is scheduled to be operational around 2020.

PBF will closely monitor the development of potential alternatives to MHF that are ***proven*** to be safe, reliable and consistent with the California's environmental goals. PBF strongly believes MHF can be used safely at the Torrance facility, and it is the only current option for the viability of the facility.

Investing in the Local Economy

In addition to providing jobs, our property and other taxes help pay for local schools, while our philanthropic giving and community volunteerism provide an extra boost. In our community, the Torrance Refinery:

- Has operated in City of Torrance since 1929 and is one of its largest tax payers.
- Employs more than 1,100 company workers and contractors.
- Pays about $130.5 million in salaries, wages and benefits.
- Generates about 15 additional jobs in the community with each refinery job.
- Contributes funding to more than 43 local nonprofits.
- Spends about $100 million in Torrance and $350 million in Los Angeles County each year on goods and services.
- Produces 10% of gasoline in California and 20% of the gasoline in southern California.

Approximately 50% of U.S. refineries use HF.

Uses in California:

- Semiconductors
- Agriculture
- Gasoline
- Refrigerants
- Water Fluoridation
- Quartz
- Pharmaceuticals
- Beer Brewing
- Home Products

Torrance Refining Company

Myth vs. Fact

Setting the Record Straight about MHF Alkylation

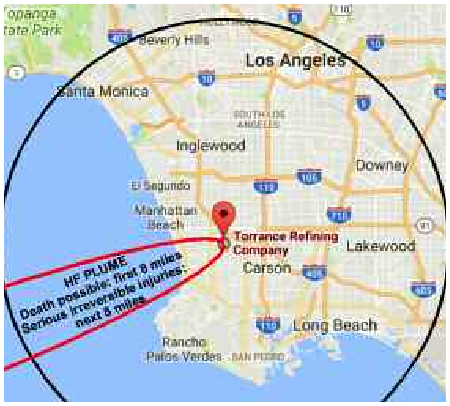
For decades the Torrance Refinery has used Hydrofluoric Acid (HF) as part of its refining process. HF is used at refineries across the country and is used to make many consumer products. The Torrance Refinery's alkylation unit uses a modified, safer version of HF called MHF, and according to experts, has some of the most advanced safety systems in the world.

At the urging of activists, the South Coast Air Quality Management District (SCAQMD) is considering banning oil refineries' use of MHF. **But these activists—led by Torrance Refinery Action Alliance (TRAA)—have made false claims and distorted data to make their case for banning the use of MHF in petroleum refining. The following are a few examples:**

MYTH TRAA claims MHF is not safe and sulfuric acid is a better alternative.

FACT **HF is used in many industries to make common consumer products such as computers, cell phones, and pharmaceuticals.** MHF is even safer than HF, and at the Torrance Refinery, it is as safe as or safer than sulfuric acid, which was determined by a Los Angeles Superior Court judge. Forcing the Torrance Refinery to switch to sulfuric acid could increase truck traffic on Torrance roads from approximately four per month to over 1,400, it would increase emissions, and it would be less energy efficient.

MYTH TRAA claims the Environmental Protection Agency (EPA)-required Risk Management Program Worst Case Scenario, depicted by these circles, identifies an area in which residents are in danger from the Torrance Refinery's MHF Alkylation Unit.



FACT The EPA explicitly cautions that "…planning circles are not intended to represent a 'public danger zone.'" Activists' have presented the graphic out of context and designed it to scare the public. **There are numerous emergency planning circles associated with other facilities throughout Southern California.** Like the refinery, these facilities are permitted to operate because they also safely manage risk.

MYTH Activists claim to be scientists who present accurate, unbiased information.

ACTIVIST-ALTERED PATENT TABLE

HF/Additive Tests Additive wt %	Temperature °F.	Pressure: 140 psig Impact Plate & Pad Yes/No	Rainout wt %
50	110	N	64
50	110	Y	99
34	90	N	53

ACTUAL, UNALTERED PATENT TABLE

Test No	HF concentration wt %	Pressure psig	Temperature °F.	Impact Plate & Pad Yes/No	Rainout wt %
	HF/Additive Tests				
34	50	140	110	N	64
36	50	140	110	Y	99
33	66	140	90	N	53
37	69	140	90	Y	94

FACT **TRAA has distorted data to support their false claims and mislead the public.** They engage in practices such as omitting the rows and columns of data from the patent table above. The omitted information actually ***supports*** the effectiveness of MHF.

TORRANCE REFINERY OVERVIEW

Safe Harbor Statements

This presentation contains forward-looking statements made by PBF Energy Inc. and PBF Logistics LP (together, the "Companies", or "PBF" or "PBFX") and their management teams. Such statements are based on current expectations, forecasts and projections, including, but not limited to, anticipated financial and operating results, plans, objectives, expectations and intentions that are not historical in nature. Forward-looking statements should not be read as a guarantee of future performance or results, and may not necessarily be accurate indications of the times at, or by which, such performance or results will be achieved. Forward-looking statements are based on information available at the time, and are subject to various risks and uncertainties that could cause the Companies' actual performance or results to differ materially from those expressed in such statements.

Factors that could impact such differences include, but are not limited to, changes in general economic conditions; volatility of crude oil and other feedstock prices; fluctuations in the prices of refined products; the impact of disruptions to crude or feedstock supply to any of our refineries, including disruptions due to problems with third party logistics infrastructure; effects of litigation and government investigations; the timing and announcement of any potential acquisitions and subsequent impact of any future acquisitions on our capital structure, financial condition or results of operations; changes or proposed changes in laws or regulations or differing interpretations or enforcement thereof affecting our business or industry, including any lifting by the federal government of the restrictions on exporting U.S. crude oil; actions taken or non-performance by third parties, including suppliers, contractors, operators, transporters and customers; adequacy, availability and cost of capital; work stoppages or other labor interruptions; operating hazards, natural disasters, weather-related delays, casualty losses and other matters beyond our control; inability to complete capital expenditures, or construction projects that exceed anticipated or budgeted amounts; inability to successfully integrate acquired refineries or other acquired businesses or operations; effects of existing and future laws and governmental regulations, including environmental, health and safety regulations; and, various other factors.

Forward-looking statements reflect information, facts and circumstances only as of the date they are made. The Companies assume no responsibility or obligation to update forward-looking statements to reflect actual results, changes in assumptions or changes in other factors affecting forward-looking information after such date.

PBF Energy

- **Publicly-traded independent petroleum refiner founded in 2008 by experienced refinery executives and private equity partners**

  Petroplus - **B**lackstone - **F**irst Reserve

- **Now PBF (NYSE: PBF) is the one of the largest independent refiners in U.S.**

- **PBF currently owns five refineries**
  - Delaware, New Jersey, Ohio, Louisiana, California, and logistics assets
  - Operated as subsidiaries companies of PBF Energy
  - ~3,050 employees including members of the USW and IBEW / employs thousands of contract workers including the Building Trades unions

- **Corporate headquarters in Parsippany, New Jersey**
  - Western Region headquarters in Long Beach, California

Torrance Acquisition

- **Purchased the Torrance Refinery and logistics assets in 2016**
  - $537.5MM total purchase price for all assets, plus working capital
    - Financing through combination of cash, debt, and equity
- **Assets acquired include:**
  - 155,000 bpd Refinery
  - 171-mile crude oil gathering system
  - Marine Terminal in Port of Los Angeles
  - Vernon Products Terminal and Warehouse
  - Atwood Terminal
  - Jet fuel line from Refinery to Los Angeles International Airport
  - Other crude oil and product lines in Los Angeles basin

Operations Since Acquisition

- **Focused on changing the culture**
  - Greater team work
  - Greater ownership
  - More direct involvement by management

- **Focusing on reliable operations**
  - Review of all historical programs
  - Instituted a new team focusing solely on improving refinery reliability
  - Gained more knowledge of refinery programs and processes since sale closed
    - Some strong programs such as Mechanical Integrity; some need improvement such as Electrical Reliability

Getting to the Core

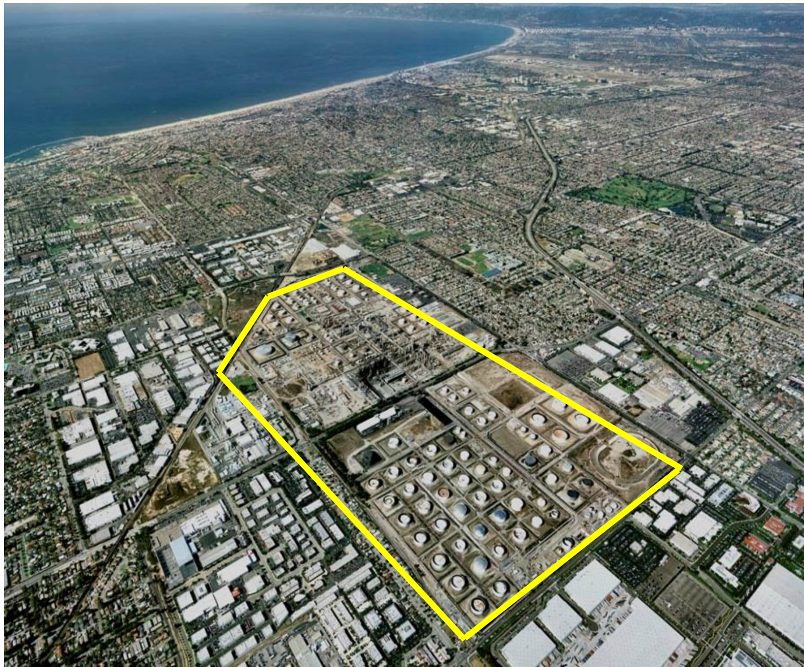
- **Our core values include:**
  - Safe, reliable, and environmentally responsible operations
  - Providing employees with opportunities to grow with the company
  - Earning the right to operate in communities that host our facilities
  - Providing superior returns to our shareholders

- **Our core growth strategy: expand and diversify through acquisition**
  - Focus: owning and operating refining and related logistics operations
    - Acquired assets become “core assets” for PBF and PBF Logistics
    - Uninterested in exploration, production, or retail marketing

Torrance Overview

Torrance Refining Company

- Operated in City of Torrance since 1929
- 750 acres – formerly bean fields
- 600+ employees / 500+ contractors
- ~150 kbd crude capacity
  - Mainly San Joaquin Valley crude
- Produces 10 percent of gasoline in California
  - 20 percent in Southern California
  - Also supplies Nevada
- Major products include:
  - Gasoline
  - Jet Fuel
  - Diesel Fuel
  - Liquefied Petroleum Gas
  - Others



Petroleum industry jobs in California: 364,032

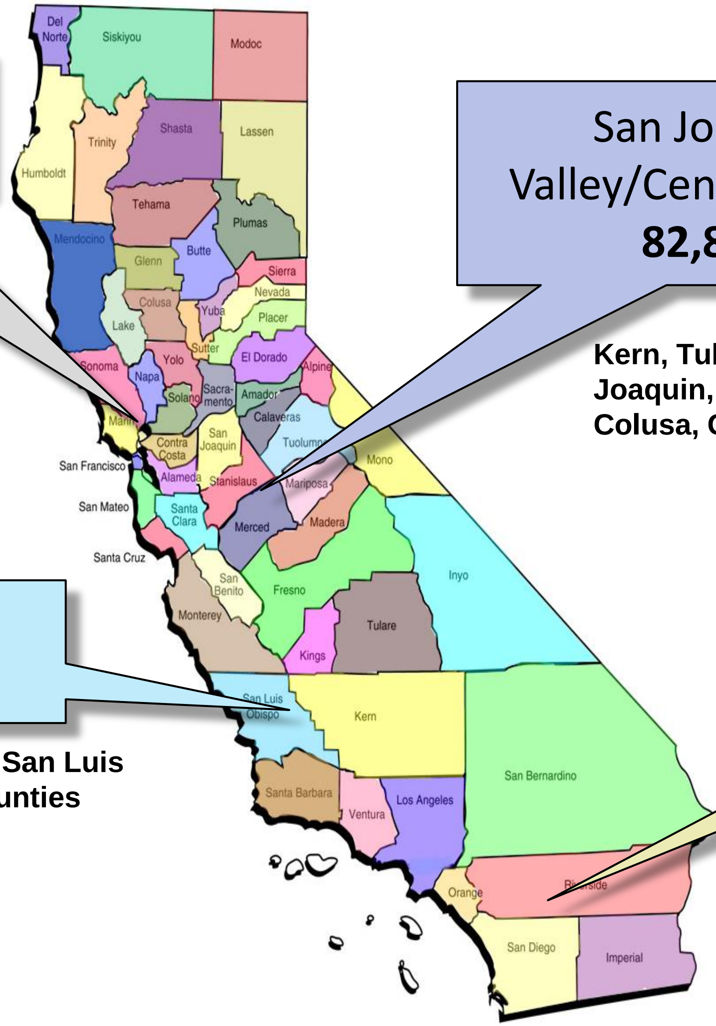
Torrance Refining Company

San Francisco Bay Area
96,859

San Francisco, Alameda, Contra Costa, Solano, San Mateo, Santa Clara, Marin, Sonoma, Napa counties

San Joaquin Valley/Central Valley
82,824

Kern, Tulare, Fresno, Merced, Stanislaus, San Joaquin, Sacramento, Sutter, Yuba, Yolo, Colusa, Glenn, Butte, Tehama Shasta counties



Central Coast
19,238

Ventura, Santa Barbara, San Luis Obispo, Monterey counties

Southern California **124,141**

Los Angeles, Imperial, Orange, Riverside, San Bernardino, San Diego counties

Source: Purvin & Gertz, Inc., Assessment of Petroleum Industry Economic Impact to the State of California, June 2011

**** Slide and information provided by Western States Petroleum Association***

Torrance Refining Company

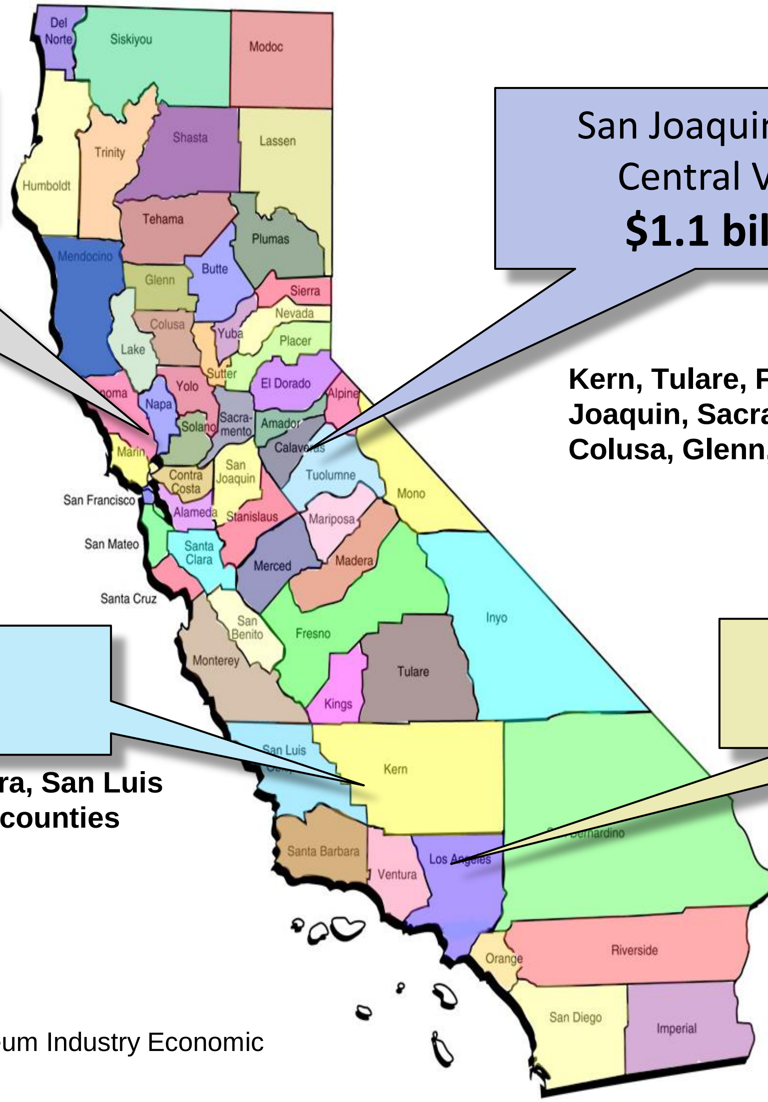
State and Federal Tax Revenues - $8.5B

San Francisco Bay Area
$1.3 billion

San Francisco, Alameda, Contra Costa, Solano, San Mateo, Santa Clara, Marin, Sonoma, Napa counties

San Joaquin Valley
Central Valley
$1.1 billion

Kern, Tulare, Fresno, Merced, Stanislaus, San Joaquin, Sacramento, Sutter, Yuba, Yolo, Colusa, Glenn, Butte, Tehama Shasta counties



Central Coast
$307 million

Ventura, Santa Barbara, San Luis Obispo, Monterey counties

Southern California
$3.7 billion

Los Angeles, Imperial, Orange, Riverside, San Bernardino, San Diego counties

Source: Purvin & Gertz, Inc., Assessment of Petroleum Industry Economic Impact to the State of California, June 2011

** Slide and information provided by Western States Petroleum Association*

Petroleum Industry Economic Impacts

Petroleum industry includes large multiplier impacts.

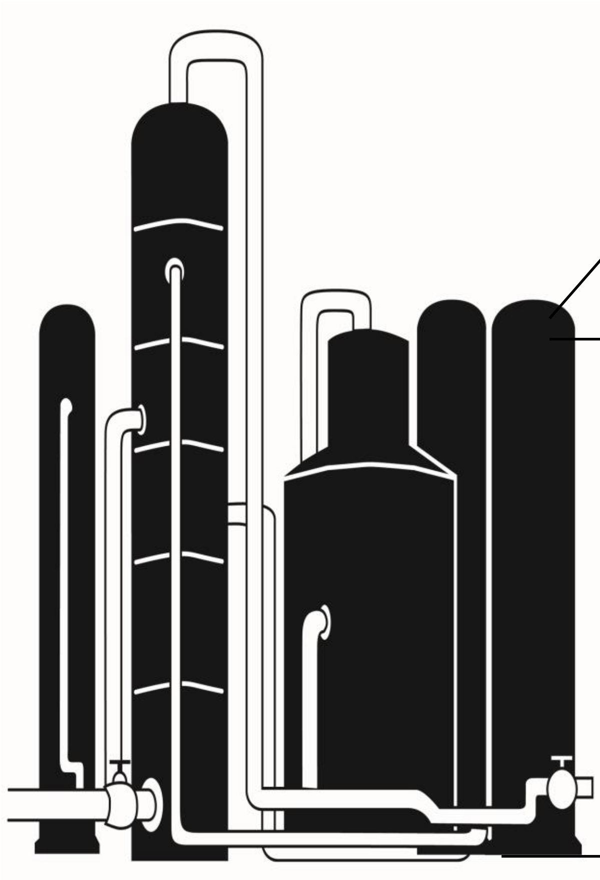
- Petroleum industry jobs are good, high-paying jobs.
- Average annual wages and benefits for refinery workers in California is $128,000
- Average annual wages and benefits for oil field workers in California is $129,000

Source: Purvin & Gertz, Inc., Assessment of Petroleum Industry Economic Impact to the State of California, June 2011

** Slide and information provided by Western States Petroleum Association*

- Every oil field job produces 5.3 more jobs in the economy
- Every refinery job produces 9 more jobs in the economy
- Every pipeline transport job produces 5.6 more jobs in the economy
- Total payroll from petroleum industry jobs is **$22 billion** (direct and indirect)

Products We Produce



70% **Gasoline** (Super Un-lead)

10% **Jet Fuel** (Military & Commercial Use)

5% **Diesel Fuel**

3% **Liquid Petroleum Gas** (Propane/Butane)

Other products from the Refining Process

12%

- **Petroleum Coke**
- **Carbon Dioxide**
- **Sulfur**

Operating Events Since Acquisition

- On July 11th, we were performing planned maintenance at the refinery that resulted in the shutdown of several units and caused flaring.
  - All shutdown systems worked properly.
- The refinery experienced power outages in September and October, which completely shut down the refinery on both occasions.
  - SCE accepted responsibility for both of the outages
  - Working cooperatively with SCE, with the support of the SCAQMD and City of Torrance to get SCE to move forward with reliability improvements on their system.
  - Currently PBF and SCE are exploring short-term (in progress), intermediate (18-24 month execution) and long-term reliability improvement options (8-10 year execution) to improve reliability on their system.
  - PBF and SCE meet with the City of Torrance monthly and frequently with SCAQMD to provide updates
- On November 15, planned maintenance was being performed when a fire in a process area occurred. Refinery personnel quickly assessed the situation and extinguished the fire.
  - All safety systems at the refinery operated properly and there were no injuries.
  - Fire isolated to small area and all equipment and instrumentation in the area thoroughly tested before being brought back online.
  - The root cause of the incident is currently under investigation.

Torrance Refinery Alkylation

- **One of Torrance Refinery's most important units is a modified hydrofluoric acid (MHF) unit that is critical to its ability to make gasoline to meet California's strict requirements –** the strictest in the world.
- **Petroleum refineries use two distinct processes to manufacture alkylate, a critical blending component in CARB gasoline**
  - Both processes use a liquid acid catalyst to promote the desired chemical reaction
    - Hydrofluoric (HF) acid alkylation
    - Sulfuric acid alkylation
- **HF acid and sulfuric acid alkylation have similar basic chemical reactions**
  - However, process equipment and design requirements differ significantly
  - There are also differences in product quality and catalyst consumption
- **Alkylation processes and catalysts are not interchangeable**
  - Product quality differences are also an important factor
- **Refinery configuration can also dictate which process will be more effective**
- **No U.S. refinery has ever switched alkylation units from HF to sulfuric acid**
- **Before PBF adopts any new alkylation catalyst, the technology must be proven to be safe, reliable, environmentally responsible and commercially viable in a full scale application**
  - None of the new, alternative alkylation technologies has reached a mature state of technical, commercial, and economic viability

What is Modified Hydrofluoric Acid?

- **Modified Hydrofluoric Acid** (MHF) **is Hydrofluoric Acid** (HF) **that contains an additive that lowers the volatility of the original compound**
  – Reduces risk of exposure in the event of an MHF leak or spill
- **MHF users must obtain a proprietary license from the manufacturer, which considers the additive formulation and concentration to be trade secrets**
- **Changing the alkylation process from HF to MHF requires an investment in and installation of additional equipment**
- **At higher concentrations the MHF additive can cause operational and reliability issues on the alkylation unit**
  – Limits amount of proprietary additive that can be added
- **Four domestic HF units have been adapted to use MHF catalyst technology**
  – Torrance and Wilmington, CA refineries both use MHF as an alkylation catalyst

Torrance MHF Unit Safety Mechanisms

- **Specialized training and emergency response drills**
- **Proprietary additive in "Modified HF" catalyst significantly reduces volatility versus conventional HF**
- **Surveillance via eight video camera systems that can be used with nine remotely-controlled "aim and shoot" water cannons to suppress MHF vapors**
  - Fixed Water Spray System & Fixed Water Monitors also suppress vapors
- **Unit shutdown, equipment isolation, rapid de-inventory system moves MHF to safe location**
  - Deluge System / Spray Curtains deploy with equipment shutdown and isolation
- **Laser Sensor system on perimeter of unit provides 360° coverage**
- **29 MHF detectors near high acid concentration equipment, unit perimeter**
- **Flange Shrouds, Settler Pans, Pump Barriers, plus protected storage drum, minimizes the potential vapor formation in the event of a release; therefore, keeping the majority of MHF in a liquid form**

Torrance Refining Company

Torrance MHF Unit Safety Mechanisms (Cont'd.)

- **Double mechanical or tandem seals for pumps in acid service**
- **Acid sensitive paint helps detect leaks on flanges**
- **Supplier pre-mixes the additive into the catalyst before shipping**
- **Safeguarded fresh acid unloading system**
  - Can be shut down and isolated from the truck, control house or Central Control
- **Comprehensive audits conducted by company experts, third-party consultants, and government officials**
- **Whenever a sensor detects MHF an automatic signal is sent directly to the refinery's Central Control Room and the SCAQMD office**
  - We are in the process of electronically routing the same notification signal to the Torrance Fire Department

Improving MHF Safety at Torrance Refinery

Although Torrance Refinery's alkylation unit includes many layers of protection, PBF Energy's subsidiary, Torrance Refining Company (TORC), plans to further improve process safety by:

1. Providing a direct signal from the refinery's alkylation unit MHF leak sensors to the Torrance Fire Department.
   i. SCAQMD already has this feature.
2. Evaluate potential changes to the water spray systems.
3. Conduct and upgrade MHF training for employees and emergency responders.

Torrance Community Engagement

- **Workforce Involvement Program**
  Our community engagement goes beyond philanthropic donations and event sponsorships; our team gets personally involved in the community where we operate.

- **We partner with the city and local nonprofits to make a positive impact:**
  - Vibrant Employee Volunteer Program – Education, Environment, United Way
    - Assist teacher in the classroom mentoring students
    - Provide teachers an opportunity to apply for STEAM grants ($100K)
    - Sponsor Community Earth Day and lead plantings activities at Madrona Marsh
    - Sponsor and fundraise for HomeWalk to provide housing/support services for homeless
  - Management Involvement Program – Leading by example; personal time & talent
    - Pediatric Therapy Network
    - Volunteer Center
    - Torrance Education Foundation
    - Torrance Cultural Arts Foundation
    - Friends of Madrona Marsh
    - Switzer Learning Center

Torrance Refinery Technology Workshop

David A. Dumais
Deputy Fire Chief
City of Torrance Fire Department

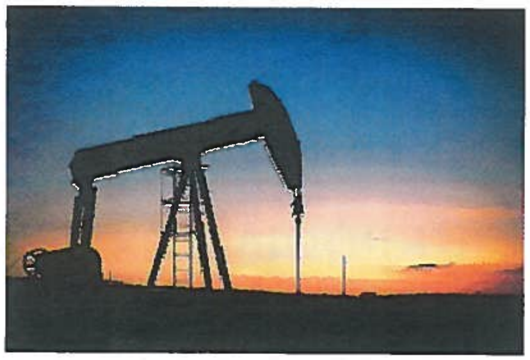
AGENDA

- Alkylation Background and Use in Torrance
- Modified Hydrofluoric Acid (MHF) Application at the Torrance Refinery
- Barrier Usage and Contribution to MHF Effectiveness
- Acid Reduction Factor (ARF) & Societal Risk Index (SRI)
- Next Steps
- Q/A

Confidential Business Information (CBI)

- The current Alkylation Technology was researched by Mobil Research and Development then became the Property of ExxonMobil when the companies merged.
- This technology was then sold to the PBF Energy and Torrance Refining Company by ExxonMobil.
- ExxonMobil maintain this technology as proprietary and therefore can not disclose without the permission of ExxonMobil and Honeywell/UOP
- COT is prevented from thoroughly disclosing the complete Alkylation technology chemistry used at the Torrance Refinery.

Why Do Refineries Have Alkylation Units?



- Refineries use many different types of processes to convert nature's complex petroleum mixtures to gasolines that burn cleanly and minimize air pollution.
- Alkylation is one of these processes that are able to help make clean fuels that minimize our "environmental footprint" and are required by CA regulations.

Alkylation History

- 1940's – Alkylation technology for high octane fuels for military aircraft
- Post WWII – Alkylate used as important component in lead-free fuels
- 1986 Goldfish Test – New concern over release and dispersion characteristics of anhydrous hydrogen fluoride (HF)
  - Torrance Fire Department requires Risk Management and Prevention Plan (RMPP) for HF use from Mobil made possible by new California legislation
- 1989 – City of Torrance files lawsuit against Mobil declaring the refinery a public nuisance

Alkylation History Cont.

- 1990 - Consent Decree Requirement – Must be as-safe/safer than the sulfuric acid alkylation (considered other viable alternative)
- 1991-1998 – Vetting by Court / Court Appointed Safety Advisor
- 1992-1993 - Mobil constructs a Pilot Plant at their Paulsboro
  - Refinery to validate Modified HF (MHF) development.
  - Based on chemistry, laboratory testing, and field testing: Using an additive, when mixed with HF, reduces its vapor-forming tendencies, with most of the HF "raining out" or landing on the ground within a short distance of a release.
- 1995 – 65% Airborne Reduction Factor (ARF) was target approved by the Court based on Court Appointed Safety Advisor vetting, laboratory tests, field tests, and testing of the Pilot Plant in Paulsboro, NJ.

Alkylation History Cont.

- 1991-1998 – Vetting by Court / Court Appointed Safety Advisor (Continued)
- 1995-1997 – Site Construction/Implementation at the Torrance Refinery
- 1997 – When scaled up to full production, unit operability/stability problems were encountered.
- 1998 –Required a reduction in additive concentration for unit stability from 65% to 50 % unbarriered ARF

  - Upgrades Applying Barrier Technology on Highest-Hazard Areas: Flanges, Recirculation Pumps, and Settlers in the Alkylation Unit

Protecting the Public

- Converting the Alkylation Unit to MHF doesn't make the process any faster, better, or more economic.

- The only reason for the conversion was to make things safer for the Torrance Community.

- ***MHF improves safety by changing- the way in which the mixture of liquids in the alkylation unit behave <u>if accidently released</u>.***

Common Alkylation Processes

- Contemporary Applications
  - Hydrofluoric Acid (HF)
  - Sulfuric Acid
- State-of-the-Art (1997) in HF Alkylation Technology Safety
  - Modified HF – Uses a Trade Secret "Additive" that works with HF catalyst
- Emerging Technologies Being Tested Elsewhere
  - Liquid Ionic Catalyst
  - Solid Catalyst
- TFD, Torrance Refining Company, and other agencies are monitoring these emerging technologies.

MHF Alkylation Unit Chemistry

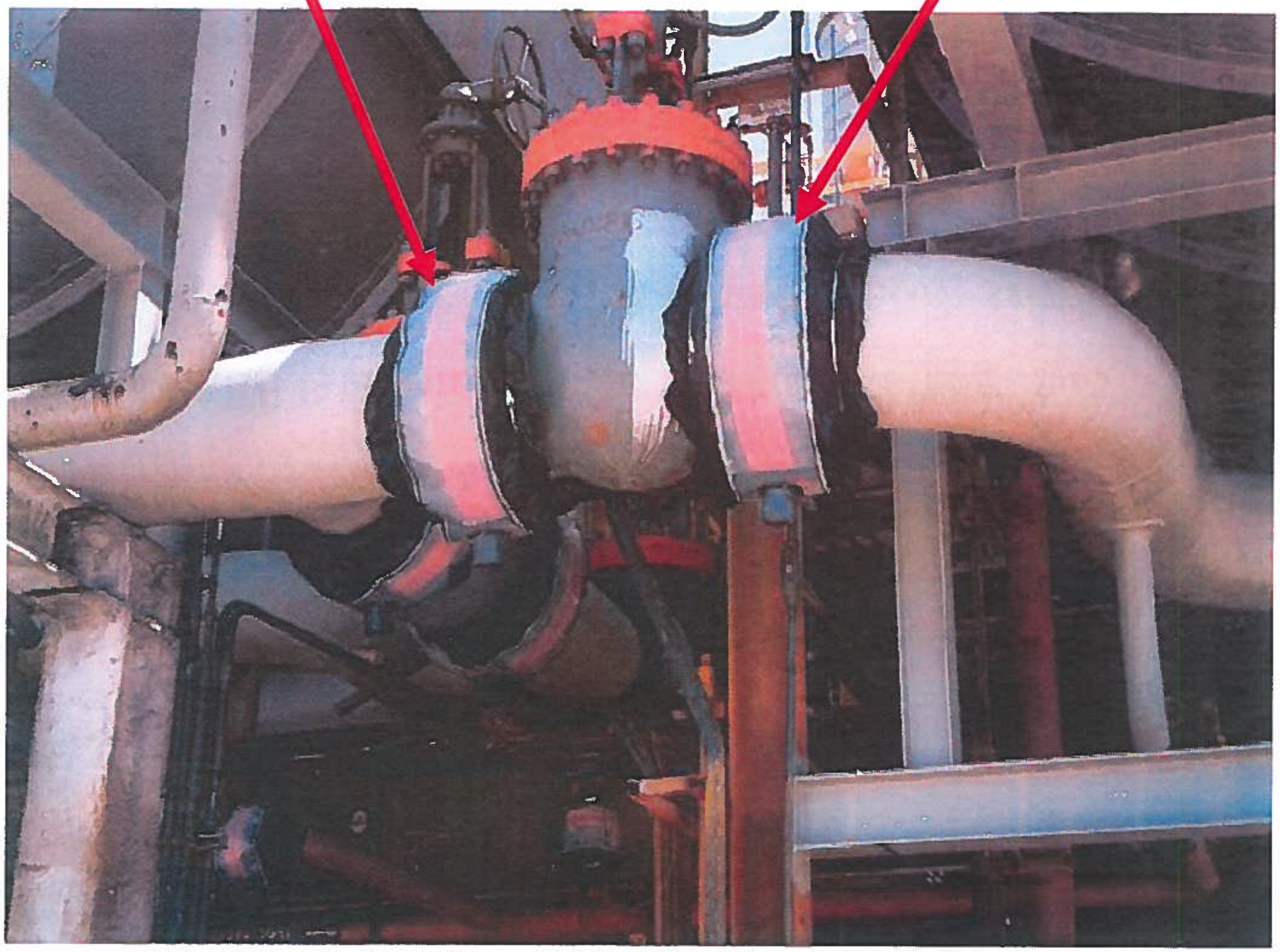
- Chemicals in Alkylation Unit
  - Normal HF (HF) is a colorless liquid that boils at 67.1F at sea level, but it is kept in its liquid state within the piping of the Alkylation Unit because it is under pressure
  - Hydrocarbon Mixture (HC)– Mostly isobutane, butylene, and propylene being catalyzed to create high-octane blending stock
  - "Additive" – Significantly decreases the potential hazard associated with an accidental release of Modified Hydrofluoric Acid (MHF)
  - ASO – Acid Soluble Oil
  - Water

MHF Alkylation Unit Chemistry - cont.

- 1994 Accepted Chemistry Yielding 65% ARF (all releases)
- 1998 Accepted Chemistry
  - Baseline Process Conditions Yielding 50% ARF (unbarriered releases)
  - 89% ARF is achieved for barriered releases
    - The application of flange shroud, settler pan, and recirculation pump enclosure barriers result in a level of safety the same or better than that approved in 1994.

Barrier Systems

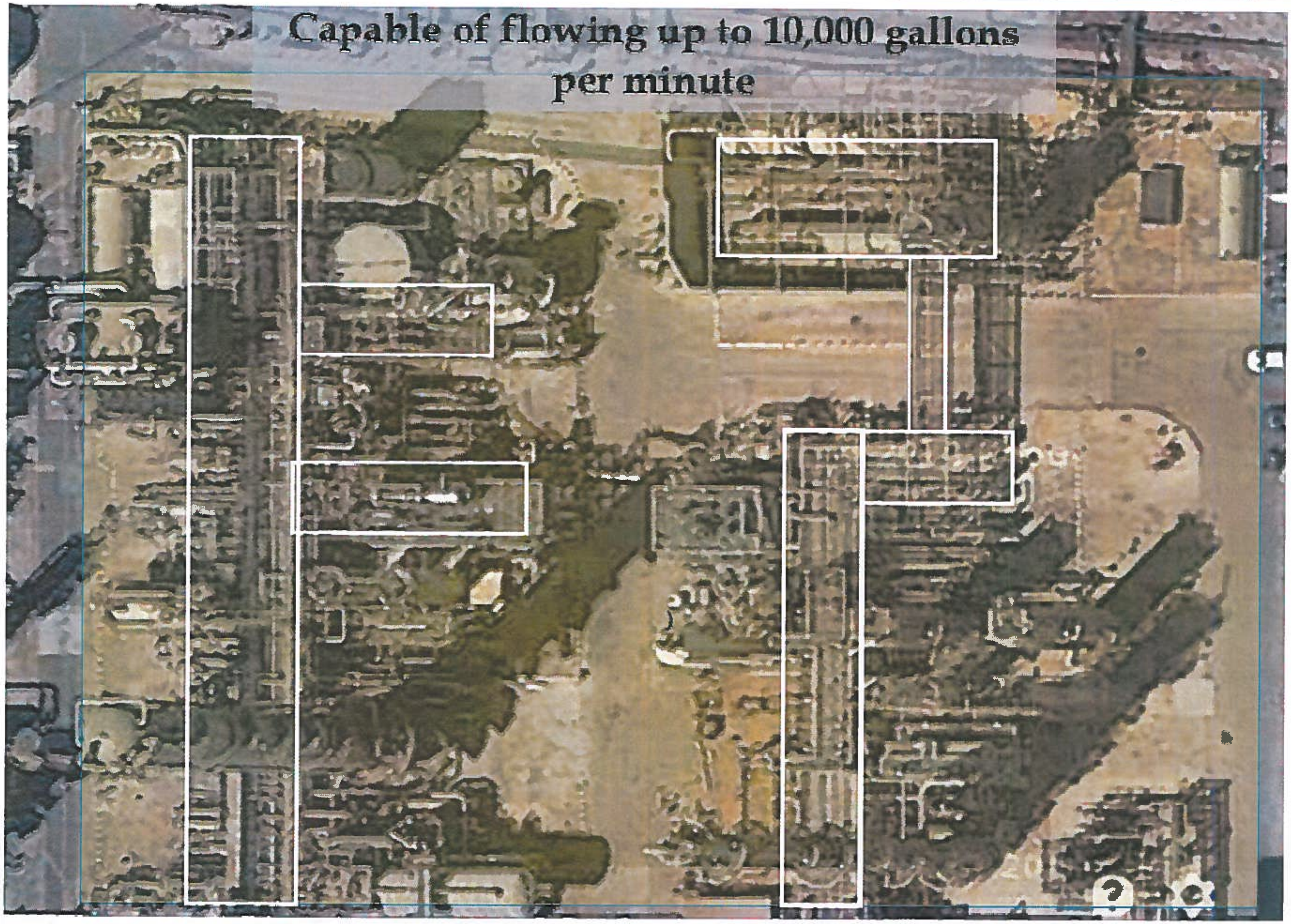
Flange Shrouds



Barrier Systems

Settler Pan

Water Deluge System



Airborne Reduction Factor (ARF)

- **Airborne Reduction Factor (ARF)** is a measure of the reduction in the amount of HF that will go airborne (as a fraction of the total HF released) in an incident.
- The larger the ARF, the less MHF is becomes airborne, and the lower the risk.
- ARF is primarily driven by:
  - HF Concentration
  - Additive Concentration
  - Water Concentration
  - Temperature
- ARF affects the severity (consequences) of a potential accidental release from the Alkylation Unit.
- Continuous monitoring of these properties through ARF reports sent to TFD daily

A Little Goes a Long Way

- Many things in the life are non-linear. At the grocery store, a gallon of milk doesn't cost 4 times the price of a quart. Non-linearity can also apply to chemistry and physics.
- For the Torrance Refinery Alkylation Unit, the additive's protective features are non-linear.
- Incremental safety benefits are greatest at lower concentrations. I.e., doubling the additive concentration does not double the safety improvement.
- So, with respect to additive concentration, "a little goes a long way." The first small percentages of additive have the most impact on ARF. This non-linearity is why the adjustment for operability in 1998 only reduced the ARF from 65% to 50%.

How Does ARF Protect Me

- MHF (1994) Original Additive Concentration

MHF + Pressure + Temp = 65% ARF

- MHF (1998) Revised Additive Concentration (unbarriered)

MHF + Pressure + Temp = 50% ARF

- MHF (1998) Revised Additive Concentration with Barriers

MHF + Pressure + Temp = 89% ARF

Societal Risk Index (SRI)

- ARF is a “release behavior” property of MHF that is a mass of chemical properties and process conditions.

- Societal Risk Index (SRI) is a measure of risk to the public – The lower the SRI, the lower the risk.
  - Measure risk as a function of severity and likelihood of impact to the Community
  - The MHF system is performing as designed and as approved by the Consent Decree

- Whereas, ARF influences the severity of a release event, SRI pulls together all potential release scenarios that could be envisioned by the designers, operators, and the Safety Advisor to balance consequences and likelihood to determine risk.

Societal Risk Index (SRI)

- SRI is Influenced by numerous design and operational characteristics that include:
  - Process Chemistry
  - Process Temperature and Pressure
  - Number of Acid delivery Trucks
  - Momentum Reduction Barriers – Flange Shrouds, Settler Pans, Recirculation Pump Enclosures
  - Firewater Monitors/Deluge Systems
  - Acid Evacuation System (AES)
  - HF Detectors

***TFD is notified if any of these elements are not fully functional, and immediate steps are taken to ensure the safety of public.**

Next Steps

- Continue to monitor the refinery safety systems as designed
- Continue to receive all compliance reports
- Create a Refinery Community Safety Agreement
- Summer 2017 - Strengthen the California Accidental Release Prevention Program (CalARP) and Process Safety Management (PSM) regulations

Next Steps - Continued

- The CalARP Program 4 requirements state that the refinery must evaluate Inherently Safe Technology (IST) and justify why application would be inappropriate. The City has the authority to contest, with reason, any justifications provided by the refinery as part of their Hazard Consequence Analysis (HCA).

- Ability for City to direct the Torrance Refinery to evaluate the need for the application of an inherently safer technology (e.g., liquid ionic technologies being considered for other US refineries)

Questions?

State Building and Construction Trades Council
of California
ROBBIE HUNTER
PRESIDENT
J. TOM BACA
SECRETARY-TREASURER
Established 1901
Chartered by
BUILDING AND CONSTRUCTION TRADES
DEPARTMENT
AFL - CIO

January 17, 2018

The Honorable William Burke
Chair of the Governing Board
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

RE: PR 1410 - Opposition to MHF Ban

Dear Dr. Burke:

I am writing on behalf of the over 400,000 Building Trades members throughout California in opposition to any ban or phase-out of modified hydrofluoric acid (MHF).

The State Building Trades have been at the forefront of pushing environmental measures forward in California. From working closely with Governor Brown on climate goals to securing the permitting for renewable energy generation throughout the state, we have not only talked the talk when it comes to environmental activism but we have walked the walk. And by doing so, we have not only moved positive public policy forward, but we have also created thousands of jobs for our members.

We have also been in California's oil fields and refineries for generations. We believe in the oil and gas industry not only because it supports millions of jobs statewide, but also because it is the right thing to do for all of California.

No matter how many solar fields we get online in the next ten years, we will still be dependent on oil and gas for decades to power our buildings and cars and to move our economy forward. If we are not refining in California, we will be depending in large part on foreign sources of oil and gas that do not enjoy the same environmental or labor laws that we do in California.

If we allow an extremist anti oil agenda to utilize scare tactics to kill an industry, the millions of California jobs that are currently supported by the oil and gas industry will go the way of McDonnell Douglas and Boeing and Ford, employers that were no longer welcome in California who took their LA based jobs and tax revenue elsewhere.

At this point in history, we should all be working together to support the industries in California that support Californians. This includes the oil and gas industry. We can, and we do, refine oil and gas responsibly and safely in California. Thousands of building trades members work in the

1231 I Street, Suite 302 · Sacramento, CA 95814-2933 · (916) 443-3302 · FAX (916) 443-8204

oil and gas industry and proudly participate in powering California. Please support those members, thousands of jobs, and oppose any ban or phase-out of MHF.

Thank you for your consideration.

Sincerely,

ROBBIE HUNTER
President

RH:bp
opeiu#29/afl-cio

cc: Members, South Coast Air Quality Management District Governing Board

HF Valero 2003

Highly Toxic Chemical to be Phased Out at Valero Refinery

Feb. 7, 2003

As Part of Environmental Justice Initiatives

Southland air quality officials today approved an enforceable agreement with the Valero oil refinery in Wilmington to phase out the facility's use of the toxic chemical hydrogen fluoride by 2006.

"Once this refinery stops using concentrated hydrogen fluoride, we will have virtually eliminated the potential for a catastrophic accidental release of this compound in our region," said Barry Wallerstein, executive officer of the South Coast Air Quality Management District.

"We commend Valero for voluntarily phasing out this chemical, which will significantly increase the safety of thousands of residents living near this refinery," he said.

The agreement fulfils one of the 23 Environmental Justice goals adopted by AQMD's Governing Board last fall.

Hydrogen fluoride (HF) is a pungent, highly corrosive acid used at oil refineries in a process called alkylation that boosts gasoline octane. HF also is used at chemical plants to manufacture compounds including refrigerants.

The chemical poses a risk to nearby residents and businesses because in the event of an accidental release, it can form a dense, fuming cloud capable of etching glass and causing severe damage to human skin and lung tissue.

In 1987, an accidental release of HF resulted from an explosion at the Mobil refinery in Torrance. The same year, there was an accidental HF release at the Marathon Oil refinery in Texas City, Texas.

Under terms of the agreement, the Valero facility, also known as the Ultramar refinery, will:

- Replace its use of HF by Dec. 31, 2005, with modified HF, which contains additives that significantly reduce the chemical's ability to form a vapor cloud in the event of an accidental release;
- Enhance its existing safety systems to minimize the impact of an accidental HF release; and
- Pay a penalty of $1 million if it fails to meet the deadline for phasing out HF, barring unforeseen circumstances.

In addition, if for any reason Valero does not phase out its use of HF, AQMD will seek to expeditiously adopt a rule requiring them to do so.

The Valero facility will undergo significant construction to switch to modified HF. AQMD has pledged to expedite the processing of air quality permits needed for the construction.

Switching to modified HF will minimize the possibility of a catastrophic accidental release not only at the refinery, but along Southland transportation corridors, as the additive is added to the chemical before shipping.

HF History

In the late 1980s, four oil refineries and one chemical plant in the Southland used HF. Following the 1987 accidental release of HF in Torrance, AQMD formed a task force and the agency's Governing Board adopted Rule 1410 in 1991 to phase out the use of HF by 1998. The rule was challenged in court by industry and a Superior Court judge suspended the rule on a technicality in 1992.

Since then, two of the refineries using HF have shut down, one has voluntarily switched to modified HF and the chemical plant has phased out its HF use, leaving the Valero refinery as the only facility in the region still using the hazardous chemical.

AQMD is the air pollution control agency for Orange County and major portions of Los Angeles, San Bernardino and Riverside counties.

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SUBMIT

South Coast Air Quality Management District

21865 Copley Dr, Diamond Bar, CA 91765

909-396-2000

RESOLUTION NO. 2017-23

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF TORRANCE, CALIFORNIA, REGARDING THE SAFETY OF THE TORRANCE REFINERY.

WHEREAS, the safety and security of Torrance residents and persons who work in the city is the highest priority for the Torrance City Council; and

WHEREAS, the Torrance Refinery was established in 1929 and it and its workers make numerous contributions to the local and regional economy; and

WHEREAS, the Torrance Refinery has experienced several operational challenges since the explosion on February 18, 2015, including excessive flaring, fires, and power interruptions; and

WHEREAS, the City of Torrance has taken an active role in coordinating efforts by various local, state and federal regulatory agencies tasked with refinery safety, regulations, and oversight; and

WHEREAS, the City of Torrance has held several public workshops to educate the community regarding refinery operations and safety; and

WHEREAS, the City of Torrance submitted a project for the $2.7 Million South Coast Air Quality Management District (SCAQMD) Supplemental Environment Project (SEP) Fund Air Quality Improvement Projects for an offsite real-time air quality monitoring system with sirens available to the public, an enhanced integrated community alarm/notification system, and broad shelter-in-place air quality emergency preparedness community training; and

WHEREAS, the City of Torrance holds monthly meetings with representatives of the Torrance Refining Company and Southern California Edison to address electrical reliability concerns; and

WHEREAS, as part of California Governor Brown's directive to create Refinery Emergency Preparedness and Safety Regulations, the Torrance Deputy Fire Chief is serving as the Chair of the Interagency Refinery Task Force Training Workgroup while participating on all rule making efforts by the California Environmental Protection Agency (Cal EPA) in developing the California Accidental Release Prevention (CalARP) and the California Department of Industrial Relations (DIR) - Occupational Safety & Health Standards Board (OSHSB) for Process Safety Management for Petroleum Refineries; and

WHEREAS, City staff are members of the SCAQMD Working Group for proposed amended Rule 1118 (Control of Emissions from Refinery Flares) and will participate in the upcoming Rule 1410 (Hydrogen Fluoride Storage and Use) amendment process; and

WHEREAS, the City supports monitoring the efforts to seek a safer catalyst.

NOW, THEREFORE BE IT RESOLVED THAT THE CITY COUNCIL OF THE CITY OF TORRANCE HEREBY supports the efforts of the following stakeholders in ensuring and enhancing the safety of the Torrance Refinery and encourages all interested parties to continue to work together in addressing community concerns regarding the safety of the Torrance Refinery:

- California Interagency Refinery Task Force
- California Environmental Protection Agency (Cal EPA) in developing the California Accidental Release Prevention (CalARP)
- California Department of Industrial Relations (DIR) – Occupational Safety & Health Standards Board (OSHSB) for Process Safety Management for Petroleum Refineries
- South Coast Air Quality Management District Rule 1118 and Rule 1410 specifically related to flaring events and continued use of modified hydrofluoric acid (MHF)
- Torrance Refining Company and Southern California Edison electrical reliability project
- U.S. Chemical Safety Board
- Congressmember Maxine Waters and Congressmember Ted Lieu
- Assemblymember Al Muratsuchi's legislative efforts
- County of Los Angeles Board of Supervisors
- Concerned Citizens

INTRODUCED, APPROVED, and **ADOPTED** this 29th day of March, 2017.

Mayor Patrick J. Furey

APPROVED AS TO FORM:

JOHN L. FELLOWS III, City Attorney

by ______________________
Patrick Q. Sullivan, Assistant City Attorney

ATTEST:

Rebecca Poirier, MMC, City Clerk

TORRANCE CITY COUNCIL RESOLUTION NO. 2017-23

STATE OF CALIFORNIA)
COUNTY OF LOS ANGELES) ss
CITY OF TORRANCE)

I, Rebecca Poirier, City Clerk of the City of Torrance, California, do hereby certify that the foregoing resolution was duly introduced, approved, and adopted by the City Council of the City of Torrance at an adjourned regular meeting of said Council held on the 29th day of March, 2017 by the following roll call vote:

AYES:	COUNCILMEMBERS	Ashcraft, Goodrich, Griffiths, Herring, Rizzo, Weideman, and Mayor Furey.
NOES:	COUNCILMEMBERS	None.
ABSTAIN:	COUNCILMEMBERS	None.
ABSENT:	COUNCILMEMBERS	None.

Date: 3/30/17

Rebecca Poirier, MMC
City Clerk of the City of Torrance

Torrance Refining Company

January 16, 2018

Setting the Record Straight

The Truth About Torrance Refinery MHF

Purpose of This Presentation

- **To set the record straight by telling the truth about Torrance Refinery's use of an alkylation catalyst called modified hydrofluoric acid (MHF), which is the newest, commercially viable alkylation technology available**

- **Present facts based on testing, modeling, and research by qualified experts**
  - Correct misinformation in these presentations by the grassroots organization Torrance Refinery Action Alliance - TRAA
    - "The Case Against MHF, -ARF-SRI-and Barriers-" (Jan. 4, 2017)
    - TRAA's feedback to Torrance Fire Department (Feb. 28, 2017)
  - Provide correct information for use in South Coast Air Quality Management District (SCAQMD) 1410 rulemaking process
  - Address community concerns generated by misinformation

- **Provide insights regarding issues raised at public meetings and hearings**

Torrance
Refining Company

Table of Contents

Torrance Refining Company

Chapter 1: Refinery Statement & Background Information

We recognize we have to continue to earn the right to operate in the communities that host us.

Since acquiring the refinery on July 1, 2016 PBF Energy has been investing in our people, processes, equipment and procedures to improve refinery operations.

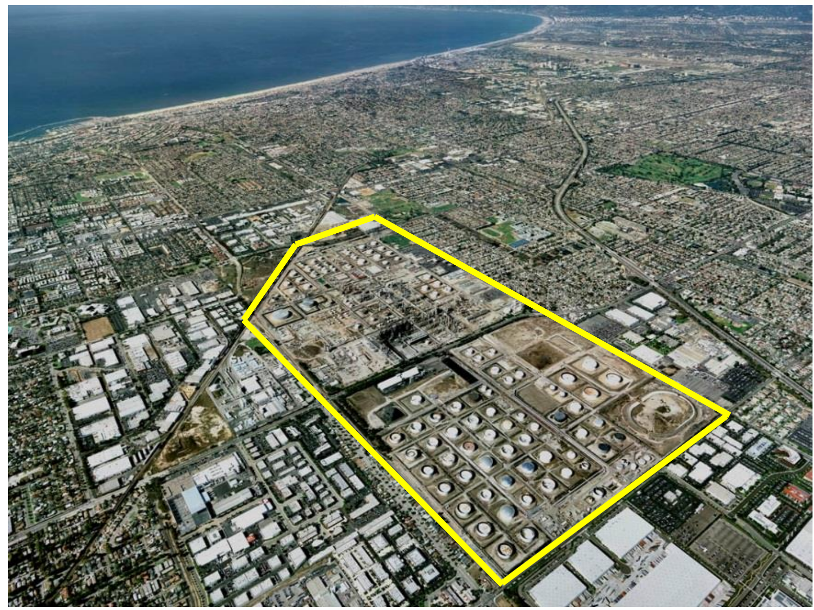
Everyone who works at the Torrance Refinery today is committed to safe, reliable, and environmentally responsible operations.

The Alkylation Unit with its MHF catalyst are critical to the refinery's future - this Additive represents the most recent proven alkylation technology.

Our goal is to operate the best refinery in the State of California and the world…we're working smartly and diligently on achieving this goal!

Torrance Refinery

- **Economic cornerstone for the City of Torrance**
  - Continuous operation on 750 acres since 1929
- **585+ employees / 320+ contractors**
  - ~300 families with ties to Torrance
  - Turnarounds require additional contractors
    - Spring 2017: ~1875 contractors at peak
- **~150,000 barrels per day (bpd) crude capacity**
  - Processes crude oils primarily from California
  - Makes gasoline, jet fuel, diesel, other products
- **Supplies ~20% of SoCal's gasoline demand**
  - ~10% of California's overall gasoline demand
  - Also supplies gasoline to Nevada & Arizona
  - Supplies ~25% of LAX jet fuel demand
  - Supplies ~65% of marine fuel to ports of L.A./LB
- **Uses MHF to make "alkylate" to blend gasoline**
  - Needed to make all grades of CARB gasoline



Torrance Refining Company

Key Priorities

- **Protect our workers, the community, and environment through safe work practices and procedures**
- **Refinery workers are accountable, responsible, and have authority**
  - To stop work for any safety concern
  - To shut equipment down for any safety concern
- **Continue improving our operational reliability to achieve safe, environmentally responsible operations**
  - A safe and reliable refinery will also keep the community safe
- **Earning the right to operate in this community**
  - Torrance Refinery meets with community groups frequently
  - We continue to work cooperatively with city officials and regulatory agencies
  - We have renewed efforts to explain to the community what we do, our safe practices and the refinery's local and regional socioeconomic contributions

Chapter 2: MHF Alkylation & How MHF Works

- **Alkylate: critical, "clean" gasoline blending component also increases octane**
  - Required for making all grades of CARB gasoline
- **Refineries use chemical catalysts to make Alkylate from low-value liquid petroleum gases - LPGs**
- **Catalysts used to make Alkylate**
  - Anhydrous hydrofluoric acid (**AHF**)
  - Modified hydrofluoric acid (**MHF**)
  - Sulfuric Acid
- **Each type of catalyst is safely used around the world but has unique risks**
  - HF & MHF (M**/**HF) are used in over 50% of U.S. Alkylation Units as well as globally
    - Benefit: M/HF is reused in the process
    - Sulfuric Acid requires additional processing for reuse
  - Refining configurations, feed type and product slate determine catalyst type
  - Globally, refining alkylation represents ~2% of HF end use

Use of MHF Alkylation Technology at Torrance

- **Torrance Refinery's MHF Alkylation Unit is necessary to produce alkylate, a critical component of California's CARB gasoline - the cleanest in the world**

- **Highly-qualified engineers and research scientists developed MHF in the 1990s**

- **Under the City of Torrance Consent Decree, following a rigorous review of the MHF testing and modeling data, the independent Court-appointed Safety Advisor, an LA County Superior Court Judge determined that MHF**
  - "would not form an aerosol or dense vapor cloud upon release" and MHF "(including mitigation) presents no greater risk than sulfuric acid alkylation plant producing a comparable amount of alkylate"

- **Torrance Refinery has never had an offsite M/HF release since start-up in 1966**
  - HF: used from 1966 until 1997
    - Survived 6.5+ magnitude Sylmar (1971) and Northridge (1994) earthquakes
  - MHF in use since 1997 court approval and permit from SCAQMD

Torrance Refining Company

Use of MHF Alkylation Technology at Torrance

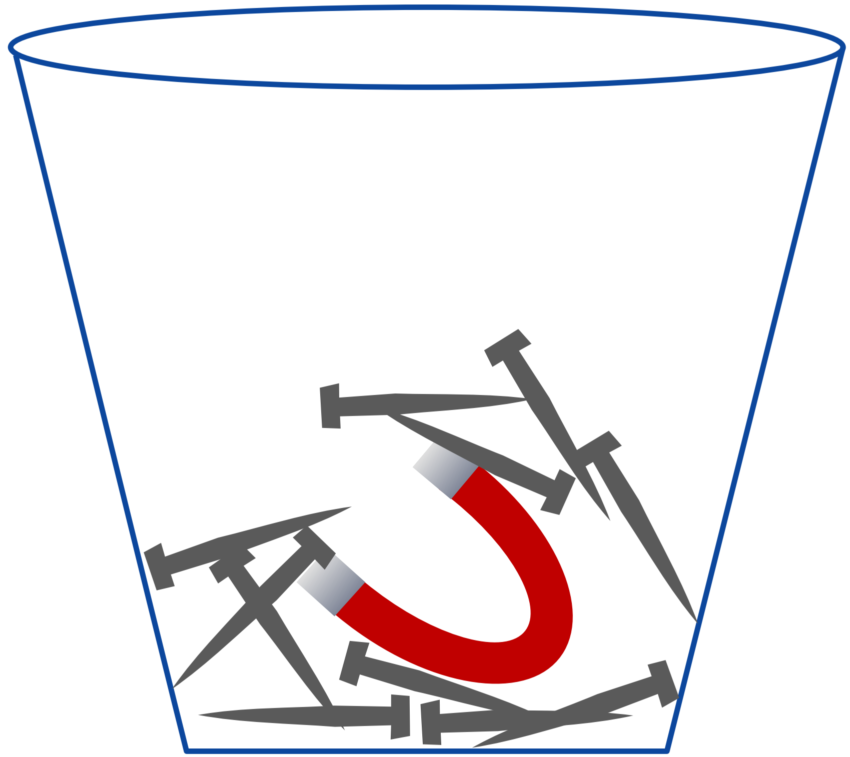
- **Excerpt AQMD: "Addendum, Mitigated Negative Declaration, Mobil Modified Hydrogen Fluoride Conversion Project", p. 2 - July 9, 1997**
  - "The experimental testing indicated that the addition of the Mobil additive to HF was an effective method for reducing or elimination the amount of aerosol formed during a release.
  - "In summary, after review of available test data and performing release/dispersion modeling, under similar release conditions the addition of the Mobil additive to an HF Alkylation unit was determined to result in a reduction of HF hazard zones for equivalent releases.
  - "In all cases, addition of the additive of the Alkylation unit will reduce the distance traveled by HF in the event of a release. At any concentration of the additive, the vapor pressure of HF will be reduced, thus reducing the potential for public exposure to HF."

MHF Works: Proven by Testing

- **HF and MHF have different characteristics and “behaviors”**
  - MHF is a different type of mixture from AHF
- **MHF works through Hydrogen Bonding**
  - Additive forms hydrogen bonds to AHF to hold MHF in Liquid Phase
  - Water also contributes to bonding AHF
- **MHF used at Torrance Refinery does not flash atomize because of hydrogen bonding**
- **Experiments in 1992 and 1994 showed the presence of the additive in AHF eliminates Flash Atomization of the release**
  - Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F
- **AQMD Quote - “Alkylation Improvement Project, Final EIR”, Chapter 2, p. 2-7 - SCH #20030536, certified 12/16/04 regarding Valero’s MHF project**
  - “The modified HF catalyst reduces acid vapor pressure sufficiently to suppress the usual flash atomization process of hydrofluoric acid, causing most of the acid to fall to the ground as an easily controlled liquid and reduces the potential for off-site consequences of an accidental HF release.”

Example of Hydrogen Bonding: Nails in a Bucket

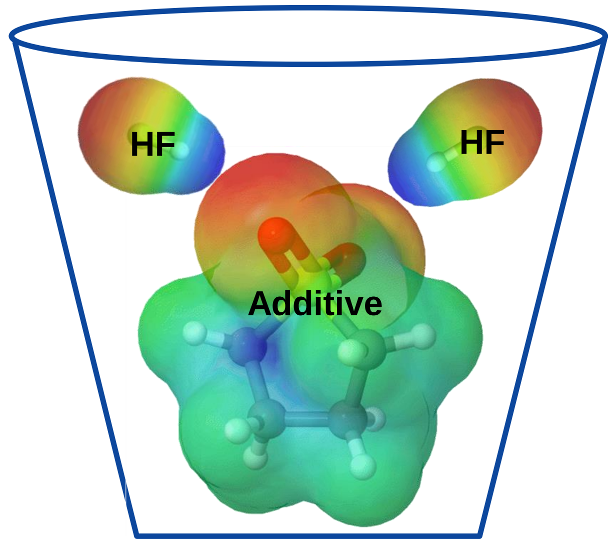
- **Visualize the nails as HF molecules**
- **Visualize the strong magnet as the MHF Additive**
- **Put the nails and strong magnet in a pail**
- **Shake the pail to move the contents around**
- **The nails - HF molecules - attach or "bond" to the magnet - Additive**
- **Additive size and strength induces further attraction between HF molecules**
- **HF molecules are attracted to the Additive and each other and bond together**



HF Bonding

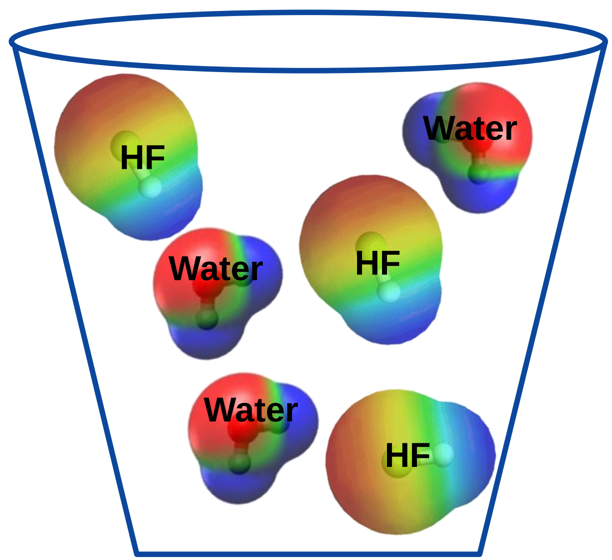
HF + Additive

- **Liquid HF chains already bond among themselves**
  - Typically five or six HF molecules per chain
- **MHF Additive acts like a strong magnet to bond HF chains**
- **Charge also distributed to surrounding HF chains**
  - Causes the chains to bond with each other
  - Reduces HF volatility over a much greater volume than just a single Additive molecule
- **A little Additive goes a long way**



HF + Water

- **On a pound for pound basis, water is an even stronger HF magnet than the MHF Additive**
- **One pound of water is roughly three times more effective at holding HF than one pound of Additive**



Torrance Refining Company

Chapter 3: Torrance Refinery Action Alliance - TRAA

- **Torrance Refinery Action Alliance (TRAA): Small, grassroots organization that has been trying to selectively ban the use of MHF in two South Bay refineries**
  - 1/4/17 TRAA's "Science Advisory Panel" released a presentation "The Case Against MHF, -ARF-SRI-and Barriers-"
  - 2/28/17 TRAA presented "The Case Against MHF, ARF-SRI-Barriers" to Torrance City Council & the public at City Hall; submitted comments refuting Torrance Fire Department's (TFD) presentation on MHF

- **Torrance Refining plus independent global HF Alkylation authorities reviewed / analyzed TRAA presentations, sources and methodologies**
  - Identified "Myths:" Incorrect, misleading, altered data and information taken out of context
  - Response: "Setting the Record Straight - The Truth About Torrance Refinery MHF"
    - Compares and corrects TRAA "Myths" with "Facts"
    - Glossary of Terms included as an Addendum for reference

MYTH - TRAA Claims: PBF has no concern for the safety and well-being of the community

TRAA Comments on Torrance Fire Department's Presentation at Torrance City Council Torrance Refinery Workshop - February 28, 2017

AGENDA
TRAA Comments

- PBF's agenda is to convince the public MHF is safe by dazzling us with technobabble and wowing us with the authority of the Consent Decree.

Protecting the Public?
TRAA Comments

- MHF conversion was done just to make things safer for the Community? That should worry you. When does the refinery put safety before profits?
- MHF is a proprietary product, never independently tested or verified. Its sole virtue is a PUBLIC IMAGE of SAFETY, but it hinders alkylation.

FACT: We recognize we have to earn the right to operate in this community

- **We want everyone inside and outside the Torrance Refinery to be safe and feel confident the refinery is in excellent hands**
- **Safe, reliable, environmentally responsible operations are core values**
- **We put safety before profits, otherwise we would be unprofitable and unsuccessful**
- **Safety of all employees and contractors working in the refinery is our utmost priority**
    - They work in safe conditions
- **PBF met with community groups and public officials before acquiring Torrance**
    - Including TRAA, Homeowners, Associations, business groups, etc.
- **<u>ALL</u> refinery workers know they are accountable, responsible and have the authority to:**
    - Stop work for any safety concern
    - Shut equipment down for any safety concern
- **We expect and want our employees to leave work in the same condition they arrived and feeling positive that they made solid contributions to the refinery**
- **A safe and reliable refinery will also keep the community safe**
    - About 300 families in Torrance have ties to the refinery

MYTH: TRAA Science Advisory Panel is knowledgeable about MHF and refining

"We performed an independent assessment of MHF using what's called proprietary data that's readily available online and there is no absence of information; there's no vacuum. We have the information we need from the industry itself - online from Honeywell, from Valero, which uses MHF and so forth **…** Incidentally, we've heard that TORC has dismissed our science panel as aerospace engineers with no refinery experience. ***We prefer to think of ourselves as rocket scientists. Luckily, knowledge of chemistry and gas dynamics is more pertinent than refinery experience in this matter, so we feel we are qualified to do the assessment."***

– *TRAA Sally Hayati, SCAQMD Hearing April 1, 2017*

Torrance Refinery Action Alliance
February 20 ·

JOIN US TONIGHT AT TRAA's MEETING, 6pm, Torrance Sizzler, 2880 Sepulveda, to celebrate the successful rally/march and prepare for this:

MHF WORKSHOP 2/28, 7pm Torrance City Hall.

The city will pour MHF safety claims straight from the refinery into the public. WE ALL NEED TO GO. Come tonight so you will understand this attempt to bedazzle us with technobabble. TRAA's Science Advisory Panel has met with city and refinery. We've revealed decades-long deception and scientific errors in MHF safety claims. This is not rocket science. 90% HF is NOT safe. Yet, we've got rocket scientists working on it—and they still won't listen (http://bit.ly/2lo3xZr).

On 2/28, tell Torrance elected representatives and public servants to detach themselves from the refinery's embrace, listen to the public, independent experts, and AQMD (http://bit.ly/2k05JEB) and support a MHF/ HF ban.

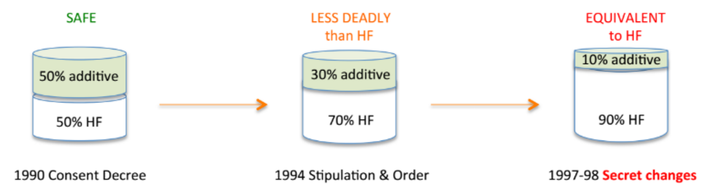
Please like/comment/share/tag to get the word out and Thank You!

Source: TRAA Facebook Page Post (Feb. 20, 2017)

MHF: Wolf in Sheep's Clothing

-False safety claims have been made for two decades-

Those claims date back to broken promises in '90, '94 for Torrance-Mobil Consent Decree



Hayati's MHF assessment is based on industry data in patents, EIRs, Safety Advisor reports, etc., with the assistance and verification of experts, including:

- Dr. Ron Koopman, HF expert, Test Director of both HF Release tests 1986 (Goldfish) & 1988 (Hawk)
- Dr. Rafael Moure-Eraso, Chemical Engineer, former Chair U.S. Chemical Safety Board (CSB)
- Dr. George Harpole, Chemical Engineer, Chief Engineer at Northrup Grumman in Redondo Beach [Harpole, 2016, "HF and MHF – Equivalent Ground Hugging Fog Hazards." <http://bit.ly/2ck2l8G>.]

Sally Hayati, TRAA 6

Source: TRAA Presentation "Modified Hydrofluoric Acid (MHF) – Wolf in Sheep's Clothing" (Nov. 16, 2016)

FACT: TRAA Science Advisory Panel members have no training or experience in Refining or Alkylation

- **Although TRAA Science Advisory Panel members may have earned advanced degrees, most have aerospace backgrounds**
  - Knowledge in this field is irrelevant to Refining or Alkylation
  - Ms. Hayati's degree is in Computer Science – not a "Rocket Scientist"
- **TRAA's "Case Against MHF" presents misinformation related to MHF Alkylation**
  - Understanding this complex field requires first-hand operational knowledge, experience, actual testing and/or modeling of alkylation technologies, particularly on efficacy of MHF
  - TRAA findings are based merely on internet searches, patent reviews, & news articles
    - Because these are insufficient to challenge the science behind MHF, TRAA resorts to filling in data gaps and / or presents predetermined outcomes/conclusions
    - Manipulating and / or altering data, particularly on patents
  - TRAA conclusions have not been tested or validated by third party
- **Contrast: Mobil, Phillips and Quest used highly QUALIFIED industry experts**
  - Experienced in the science of refining, alkylation, and dispersion modeling
    - Had in-depth technical knowledge of the chemistry and release phenomenology necessary to properly characterize MHF release behavior
    - Applied scientific rigor in testing the efficacy of MHF
  - MHF technology resulted from field and laboratory testing, and pilot plant studies

References

- *TRAA "The Case Against MHF, -ARF-SRI- and Barriers-" January 4, 2017*
- *TRAA Comments on Torrance Fire Department's February 28, 2017 Presentation at Torrance City Council Torrance Refinery Workshop*

Torrance Refining Company

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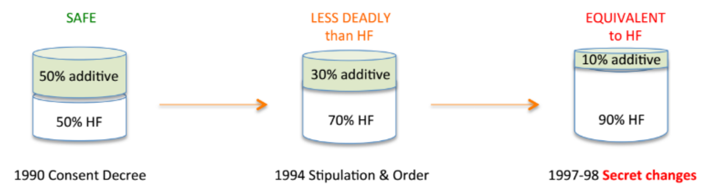

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Sally Hayati, TRAA 6

Source: TRAA Presentation "Modified Hydrofluoric Acid (MHF) – Wolf in Sheep's Clothing" (Nov. 16, 2016)

Torrance Refining Company

****Note: Purple boxes added to original image/text to highlight specific points referenced/discussed***

FACT: TRAA evaluations and conclusions appear to be based on patents and publicly available papers and include many incorrect assumptions

- **Patents are ideas - <u>NOT</u> final products developed from the ideas**
    - A final product or installation often varies significantly from the original patent
    - Many patents have **<u>NEVER</u>** been developed into a commercial product

- **When MHF was being developed, every reasonable idea generated a patent**
    - Only some ideas were advanced to a final installation
    - Many patents (ideas) were further developed with testing into a final product that was different from the patent

- **Ms. Hayati misrepresents the Additive concentrations in the depicted barrels**
    - 50% Additive was **<u>NEVER</u>** considered an option for MHF Alkylation
    - All of the patents TRAA references indicate that 50% Additive does not work as the alkylate production quality will reduce significantly

- **TRAA misinterpreted or changed some of the data they found in publicly available papers**

<u>References</u>

- *Cited throughout presentation*

Torrance Refining Company

Chapter 4: MHF has Distinguishing Behaviors

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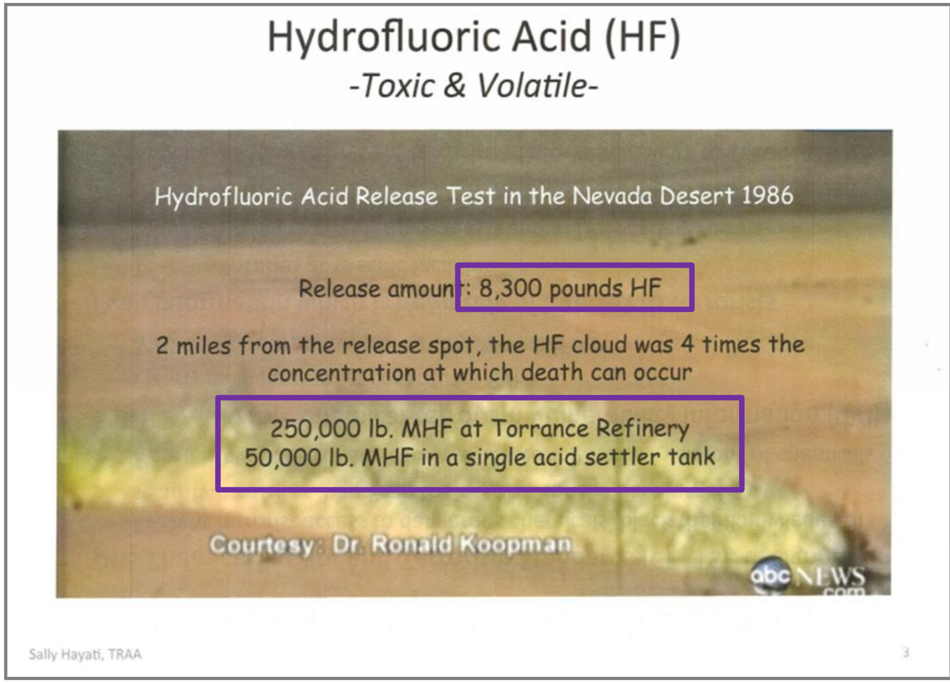
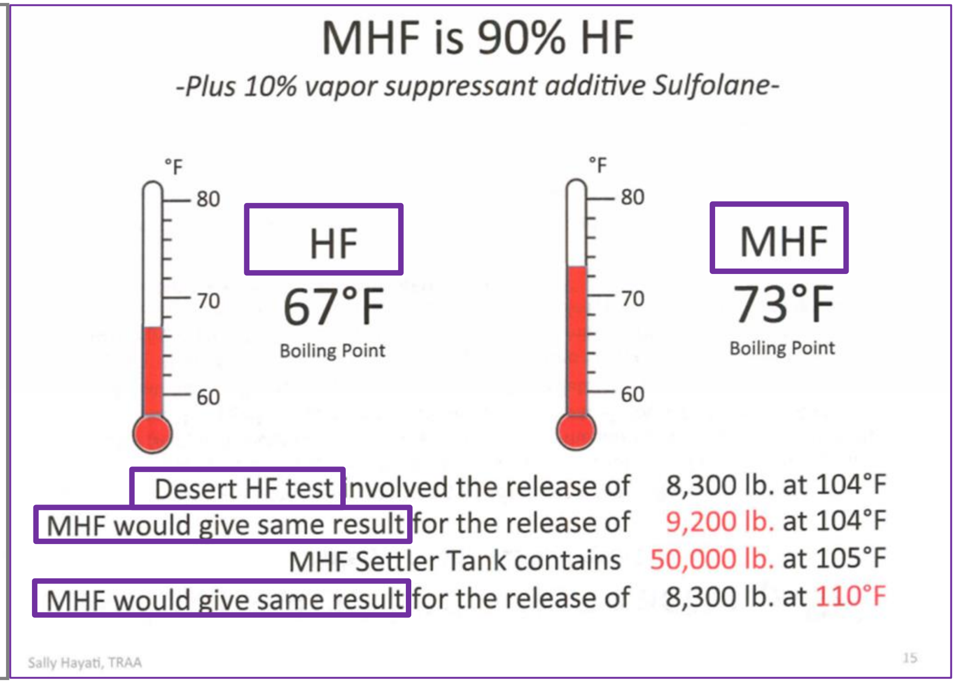
MYTH - TRAA Slides 3 & 15:
All types of HF acid behave the same

TRAA "Case Against MHF" Jan 4, 2017 – Slide 3



TRAA "Case Against MHF" Jan 4, 2017 – Slide 15



****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: Actual lab and field testing of these types of HF Acid prove each acid behaves differently

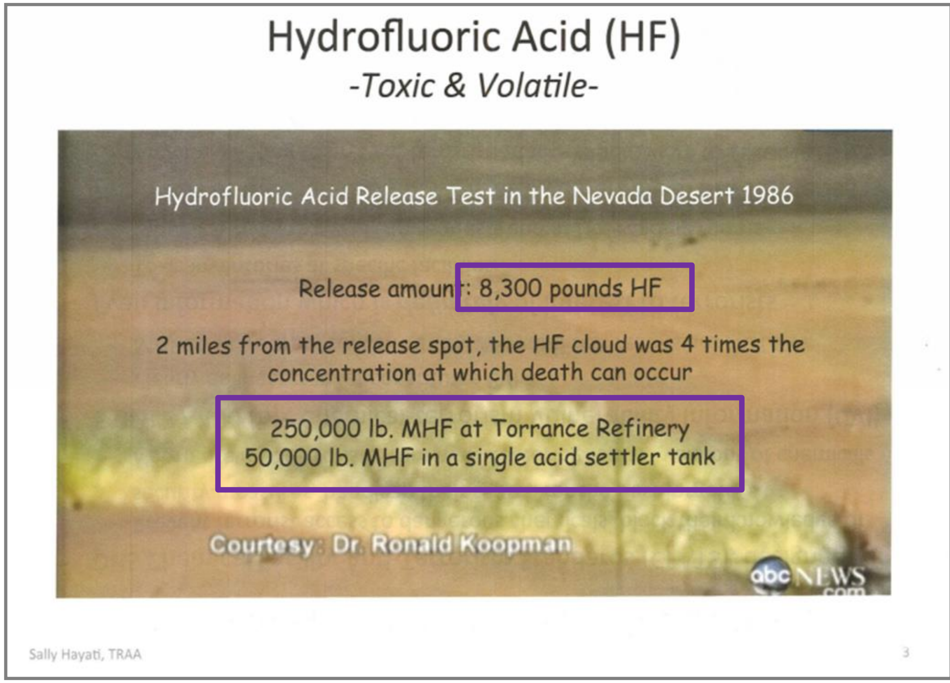
- **Hydrofluoric Acid (HF) type determines whether Flash Atomization occurs**
  - Flash Atomization: The occurrence of a substance disintegrating into extremely small droplets when a pressurized liquid is released into the atmosphere
- **Anhydrous Hydrofluoric Acid (AHF): 99.995 wt% HF – generic used in industry**
  - **Full Flash Atomization readily observed**
  - 1986 Desert Testing of AHF shown on TRAA Slide 3 was pre-MHF technology
  - HF has different characteristics - **CANNOT** be compared to MHF
- **HF-Alky Unit Acid (HF-AUA): 90-92 wt% HF – used by most refineries**
  - **Partial Flash Atomization readily observed**
- **Delivered MHF to the Torrance Refinery: 85 wt% HF, 15 wt% Additive**
  - **Flash Atomization is not observed**
- **MHF-AUA: ~80 wt% HF, ~7 wt% Additive, ~3 wt% Water, ~3 wt% ASO ~7 wt% Hydrocarbon – used by Torrance Refinery**
  - **Flash Atomization is not observed**

References

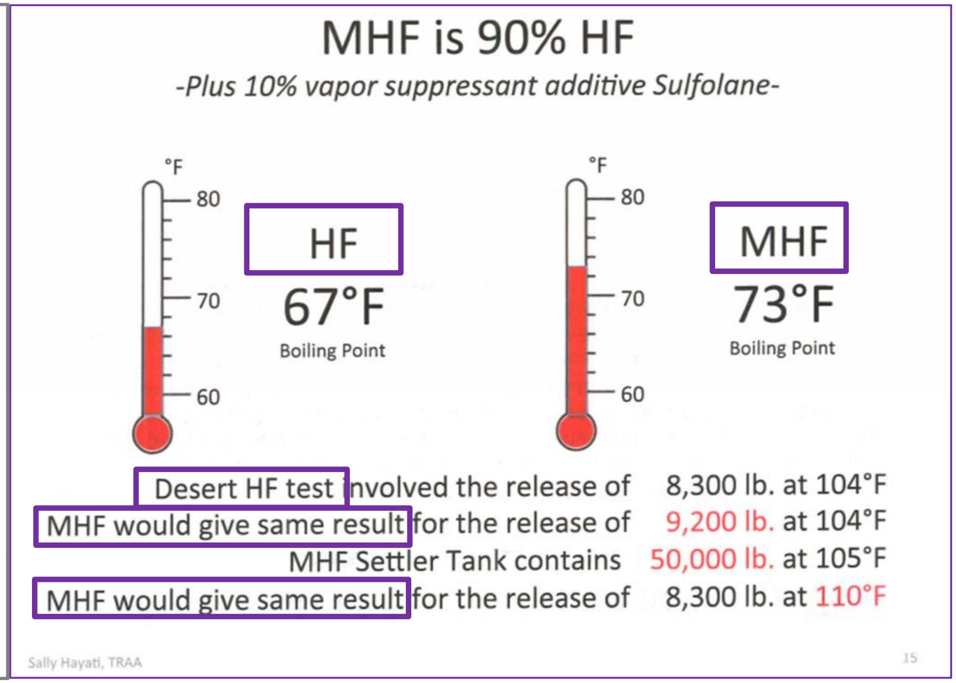
- *December 2016 ARF email submission to Torrance Fire Department*
- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*

MYTH - TRAA Slides 3 & 15:
All types of HF acid behave the same

TRAA "Case Against MHF" Jan 4, 2017 – Slide 3



TRAA "Case Against MHF" Jan 4, 2017 – Slide 15



****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: AHF tests conducted in the Nevada Desert in 1986 <u>CANNOT</u> be compared to an MHF release

- **TRAA is misrepresenting data as a scare tactic and apparently making calculations with limited knowledge**
- **Testing in 1992 and 1994 showed the Additive in MHF eliminates Flash Atomization of HF associated with a jet release**
- **Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F**
- **Torrance Refinery's MHF Alkylation chemical composition and the unit's numerous safety systems directly impact ARF and SRI**
  - **<u>CANNOT</u>** be directly compared to an unimpeded AHF release that was tested during the 1986 desert testing
- **Conclusion: Testing shows MHF <u>DOES NOT</u> form a dense, ground-hugging cloud as claimed by TRAA**
- **AQMD Quote - "Alkylation Improvement Project, Final EIR", Chapter 2, p. 2-7 - SCH #20030536, certified 12/16/04 regarding Valero's MHF project**
  - "The modified HF catalyst reduces acid vapor pressure sufficiently to suppress the usual flash atomization process of hydrofluoric acid, causing most of the acid to fall to the ground as an easily controlled liquid and reduces the potential for off-site consequences of an accidental HF release."

<u>References</u>

- *Consent Decree/Safety Advisor's Reports, May 1995 and October 1999*
- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*
- *ReVAP Tutorial page 7*

Torrance Refining Company

Chapter 5: MHF Review Process

Torrance
Refining Company

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MYTH - TRAA Slides 5, 7 & 8:
"No Proprietary Justification for MHF Secrecy"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 5

No Proprietary Justification for MHF Secrecy

-MHF is patented and therefore not eligible for trade secret rights-

Emergency Planning and Community Right-to-Know Act (EPCRA), Substantiating claims of trade secrecy Code of Federal Regulations Title 40, Section 350.7 (40 CFR 350.7) Paragraph (a) substantiation questions:

(4) The information should be a **secret of interest to competitors**
There is no MHF competitor: Honeywell has a monopoly, and since any refinery may purchase it, ExxonMobil has no claim

(4)(ii) Information claimed as trade secrets shouldn't be **publicly revealed.**
We have found the information in patents, material safety data sheets, risk management reports, and news articles on the Internet. (See following charts.)

(4)(iv) The information should be **valuable information to competitors.**
No MHF competitors exist. And if any arise, they'd find the information on-line.

(5) Disclosure should cause **substantial harm to claimant's competitive position.**
Not remotely true, for either Honeywell or ExxonMobil.

COMMUNITY RIGHT TO KNOW

Sally Hayati, TRAA 5

TRAA "Case Against MHF" Jan 4, 2017 – Slide 7

"Trade Secret" Found in the Public Domain

-The Additive for the Mobil/Phillips MHF (ReVAP) is SULFOLANE-

A dozen patents reveal what the additive is. For example:

"In order to improve the safety factors of the HF alkylation process, one option is to operate with a vapor suppressant additive in the alkylation acid. ... A number of different sulfones have been proposed for this purpose but the one generally preferred is **sulfolane**"
HF alkylation process with acid regeneration, US Patent 7847142 B2, ExxonMobil Research and Engineering Company, 2007 (filing date), http://www.google.com/patents/US7847142

Honeywell Material Safety Data Sheet for MHF reveals what the additive is.
http://bit.ly/21T6yAt

Component	CAS-No.	Weight percent
Hydrogen fluoride	7664-39-3	90.00%
Tetrahydrothiophene 1,1-dioxide	126-33-0	10.00%

Chemical Book, Sulfolane Basic information, ***Sulfolane CAS = 126-33-0***

Valero Wilmington Refinery RMP 2014: MHF 10% Sulfolane to reduce HF vapor
Valero adopted the ReVAP brand of MHF (developed by Mobil/Phillips, now owned by Honeywell) in 2005

WHY DEMAND MHF "TRADE SECRETS" IF WE ALREADY KNOW WHAT THEY ARE? For "credibility" and to eliminate uncertainty. When official data is withheld, Jill Public is easily accused of not knowing what she's talking about.

TRAA "Case Against MHF" Jan 4, 2017 – Slide 8

"Trade Secret" Found in the Public Domain

-Additive concentration used is 10%-

SOURCE 1: Torrance Refinery Safety Advisor Project, Steve Maher, "Evaluation of MHF Alkylation Catalyst (Analysis of proposed additive concentration changes)," 10/1999
– This report reveals that the additive concentration was reduced in 1998. It is unknown if it was reduced again later.

SOURCE 2: Honeywell MHF Material Safety Data Sheet (MSDS). The monopoly manufacturer of MHF.
<http://bit.ly/21T6yAt>
- Hydrofluoric acid 90.00% (also 85%)
- Sulfolane (THT) 10.00% (also 15%)

SOURCE 3: Honeywell via PBF
- A range of 10-15% is given, so it is clear the concentration used is 10%, Otherwise, Honeywell would say just 15%

WHAT IS MODIFIED HYDROFLUORIC (MHF) ACID? PBF
- **Modified Hydrofluoric Acid (MHF) is HF that contains an additive that lowers the volatility of the original compound**
  - ✓ Reduces risk of exposure in the event of an MHF leak or spill
- **The MHF used at the Torrance refinery is designed to reduce the volatility, or vapor potential, of hydrofluoric acid and features an additive that can reduce the volatility by 60 to 90 percent**
  - ✓ The MHF delivered to the refinery contains the industry standard of approximately 10 to 15 percent concentration of this additive

SOURCE 4: Valero Wilmington Refinery Risk Management Program Report 2014 (adopted same MHF in 2005)

Worst-Case Toxic Scenarios

Physical State	Gas liquified by pressure
Model Used	SLAB Model
Passive Mitigation - Other	10% sulfolane additive to reduce the HF to form an aerosol on release under pressure to atmosphere. "Diffuser" or Barrier around flange.
Confidential Business Information	No

SOURCE 5: City of Torrance Refinery Workshop October 2015. Mayor P. Furey stated MHF = 90% HF + 10% additive

Sally Hayati, TRAA 8

Torrance Refining Company

FACT: Technology licensors declared MHF information to be 'proprietary' to protect their intellectual property

- **Parties that license MHF technology, including Torrance Refining Company LLC (TORC), are legally obligated to maintain the technology's proprietary status**
- **UOP is the licensor of the MHF technology and considers the MHF testing information proprietary and trade secret**
- **Claims that product sales are an indication that related proprietary information can be publicly shared are irrelevant**
- **With Licensor consent, proprietary MHF technology information has been shared with the City of Torrance, AQMD, EPA, and Cal OSHA**
    - Permitted through licensing and confidentiality agreements, the Consent Decree, and California Public Records Act and Freedom of Information Act
- **Many references in this presentation refer to proprietary documents and data that are unavailable to the public**

MYTH - TRAA Slide 9: "Public was never informed" of change in Additive concentration in 1999

TRAA "Case Against MHF" January 4, 2017 - Slide 9

Operational Failure of MHF in 1997

- The new MHF unit with 30% additive failed at startup.
  - Unit was dangerously unstable, too little product, poor quality product
  - The public was never informed
- Mobil's actions (from Safety Advisor's 1999 report)
  - Mobil slashed additive to 10% to get HF concentration > 88%
  - Mobil added a proprietary barrier technology
  - The public was never informed

Mobil's new safety claims (from Safety Advisor's 1999 report)

1. Lowering the additive concentration didn't make much difference anyway
   "Figure IV.A.12-1b (REDACTED) clearly illustrates that significant gains in ARF are achieved at relatively low additive concentrations, and that the effectiveness curve for additional additive flattens out."
2. Mobil's proprietary barriers more than made up for the missing additive
3. Continuous calculation of ARF & SRI values guarantee community safety.

These claims are contradicted by info & data in Mobil/Phillips patents

Sally Hayati, TRAA 9

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: The Additive concentration was thoroughly vetted and approved through the Consent Decree process, which represented the public interest

- **Additive with use of barriers was thoroughly vetted and approved in the Court-ordered Consent Decree process, involving the following who represented the public interest:**
  - A well respected and experienced Superior Court Judge - Harry Peetris
  - Court Appointed Independent Safety Advisor - Steve Maher
  - City of Torrance - Mayor and Council
  - Torrance Fire Department and its independent Safety Consultants
- **1997: Torrance began using MHF Alkylation technology after AQMD issued permits**
  - The initial higher Additive concentration caused operational instability in the Alkylation Unit and generation of an undesired by-product
- **1998: Mobil approached Court-appointed Safety Advisor, City and TFD to resolve this issue**
  - Prompted reconsideration of the Additive concentration with other mitigation features
  - Through the Consent Decree process, additional testing and barrier technology review
- **1999: The Judge approved lowering Additive concentration in conjunction with the installation of barriers based on Safety Advisor recommendation after his thorough review of the barrier testing and input from City and TFD**
  - *"(Our) analysis show that the final operating configuration would provide an improvement to the level of safety to the Community*."
- **Safety Advisor's Report stated MHF Alkylation Unit ARF increased from 65% in 1995 (MHF-AUA Chemistry) to 89% in 1999 (MHF-AUA chemistry + Barriers)**
  - MHF Technology is successful

Reference

- *Consent Decree Safety Advisor's Report - October 1999*

MYTH - TRAA Slide 9: “New MHF unit with 30% additive” and “Mobil slashed additive to 10% to get HF concentration >88%”

TRAA “Case Against MHF” January 4, 2017 - Slide 9

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Sally Hayati, TRAA

9

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Torrance Refining Company

FACT: The Additive concentration was NEVER 30 wt% in 1997, but was 19 wt%

- **1997: 19 wt% MHF concentration caused operational instability and generated an undesired by-product**
  - Additive concentration is misrepresented by TRAA's lack of knowledge
- **1997-1998: Testing and review of barrier technology was undertaken to identify the optimal Additive concentration**
- **1998: Mobil approached Court-appointed Safety Advisor, City and TFD to resolve this issue**
  - Prompted the innovative reconsideration of the Additive concentration in conjunction with other passive mitigation features
  - Through the Consent Decree process, additional testing and barrier technology review
- **1999: Judge approved lowering Additive concentration with the installation of barriers for the Torrance MHF Alkylation Unit**
  - MHF Additive was reduced to ~7 wt% with an HF concentration of ~80 wt%
  - Barrier technology proven by testing
- **Torrance Refinery's MHF Alkylation Unit ARF increased from 65% in 1995 (MHF-AUA Chemistry) to 89% in 1999 (MHF-AUA chemistry + Barriers)**
  - Barrier technology added another layer of protection and safety for MHF use
  - Increase ARF supported by actual testing and information in Mobil and Phillips patents

References

- *Consent Decree Safety Advisor's Report - October 1999*
- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*
- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA, and MHF Releases*

Chapter 6: Vapor Pressure & Additive Concentration

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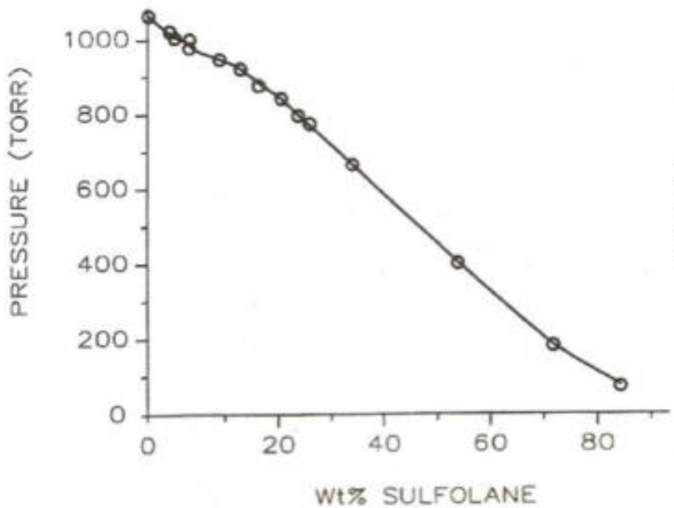
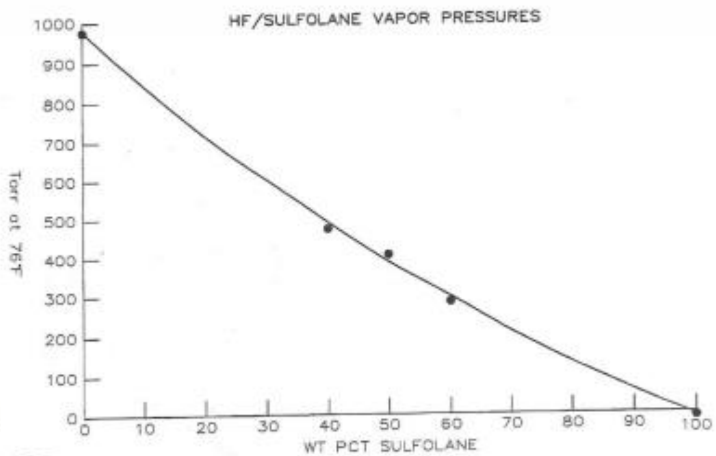
MYTH - TRAA Slide 11: “Vapor pressure is the only fluid property related to the claimed relative safety of MHF.”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 11

Vapor Pressure of 10% MHF is close to HF’s

Vapor pressure is the only fluid property related to the claimed relative safety of MHF.





Temperature 86ºF.
Phillips Petroleum Company, 1992,
European Patent EP 0796657 B1,
“Alkylation catalyst containing HF and a sulfone,”
<http://bit.ly/2hPLiNr>.

Temperature 76ºF.
Phillips Petroleum Company, 1995
US Patent 5534657,
Isoparaffin-olefin alkylation,
<http://bit.ly/2iWPonl>.

Sally Hayati, TRAA

11

Torrance Refining Company

FACT: Vapor pressure is <u>NOT</u> the key chemical property driving the effectiveness of MHF

- **Additive's primary effectiveness results from formation of hydrogen bonds that hold MHF in liquid phase**
  - Additive is a heavy liquid with very low vapor pressure that does not evaporate
- **Hydrogen bonding helps MHF resist vaporization and prevents large-scale aerosoling of the released liquid**
- **The Additive is only one component that impacts vapor pressure and aerosoling**
  - Water and Acid Soluble Oil (ASO) also have significant positive effects
- **Water is a more effective vapor suppressant than the Additive due to strong hydrogen bonding**
  - However, water content is limited to ~3 wt% to prevent accelerated corrosion
- **Effect of Additive and water on the solution's surface tension, viscosity, and enthalpy of vaporization also reduces the propensity for aerosol formation**
- **AQMD Quote - February 7, 2003, Governing Board Letter, Agenda No. 25, regarding Valero's "enforceable agreement" to phase out HF for MHF:**
  - "The unique physical properties of the additive substantially reduce the volatility of the acid at ambient conditions. This reduction in volatility proportionately reduces the amount of HF that can vaporize and subsequently disperse off-site from a given liquid release quantity."

<u>**References**</u>

- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*
- *ReVAP Tutorial page 7*

Torrance Refining Company

MYTH - TRAA Slide 12: TRAA's MHF and HF Vapor Pressure Graph is based on actual data

Referenced Article by TRAA Science Panel Member

HF and MHF – Equivalent Ground Hugging Fog Hazards

George Harpole, Ph.D., 10/21/2016

MHF (modified hydrogen fluoride) with 10% additive (10% by weight sulfolane)[1] is almost the same as pure, anhydrous hydrogen fluoride (HF). Only 1.8% of the moles or molecules are sulfolane, and 98.2% are HF. The molecular weight of HF is 20 g/mol, and that of sulfolane is 120 g/mol – so molecules of sulfolane weigh 6 times as much. Adding sulfolane to HF increases the mixture molecular weight, so increases the gas density when it evaporates in a release. Still, to exceed the effective density of air (molecular weight 29 g/mol), at least 37% by weight sulfolane (9% mole fraction) would be needed – if evaporation resulted in only pure gas. Instead, when liquid HF (or MHF) is released and mixed with air, there is substantial cooling by evaporation and by depolymerization, such as $(HF)_6 \rightarrow 6HF$[2]. The air/HF mixture temperature drops below the dew point, and a fog is formed by condensation of water vapor in the air. Then, the effective density exceeds that of air, so this becomes a ground hugging fog. The water aerosol warms up again as it absorbs the HF. But, water has low volatility, so the fog persists.

Vapor pressure is the only fluid property related to the claimed relative safety of MHF. Added sulfolane reduces the MHF vapor pressure relative to that of pure HF. Raoult's law for ideal liquids estimates the vapor pressure as proportional to mole fraction, so about 98% that of pure HF. However, the mixture is not an ideal liquid. Data show the vapor pressure of MHF (with 10% by weight sulfolane) to be 89% of that for pure HF[3]. Vapor pressures of HF[4] and MHF are shown in Figure 1 as functions of temperature. HF (boiling point 67°F) and MHF (boiling point 73°F) are both very volatile. If the MHF were 6°F (3.3°C) warmer, its vapor pressure would equal that of HF.

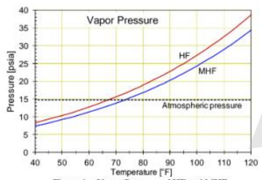


Figure 1 – Vapor Pressure of HF and MHF

In 1986, Lawrence Livermore and Amoco Oil Company conducted what has become known as the Goldfish tests. In each test, 8,300 lb of 104°F (40°C) HF was released in the Nevada desert on a smooth, dry lake bed with about a 10 mph wind. Nitrogen gas above the HF liquid pressurized the tank to about 130 psia. These conditions were selected to match what exists at refineries[5]. However, single vessels at the Torrance refinery, for example, hold six times as much HF (50,000 lb).

community in the use of MHF at refineries in urban settings.

TRAA "Case Against MHF" Jan 4, 2017 – Slide 12

MHF and HF Vapor Pressure

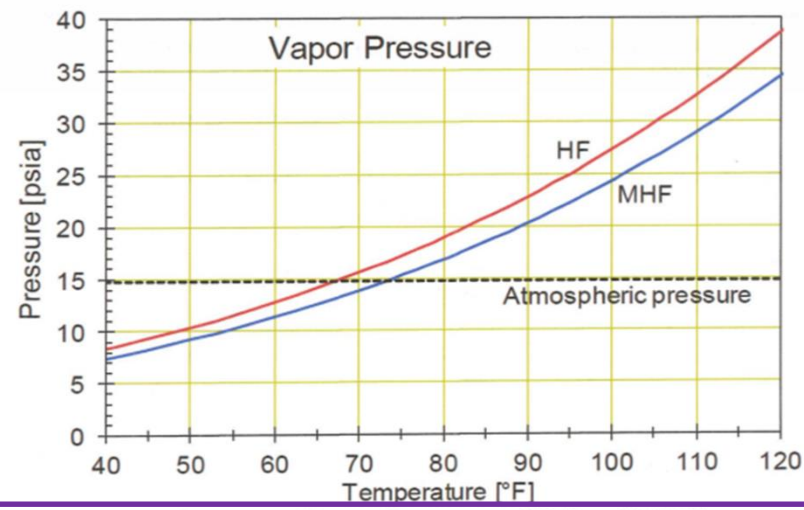


Figure 1 – Vapor Pressure of HF and MHF

George Harpole, Ph.D., Chief Engineer, Northrop Grumman Aerospace Systems, Aug 27, 2016, "HF and MHF – Equivalent Ground Hugging Fog Hazards." <http://bit.ly/2ck2l8G>.

Sally Hayati, TRAA

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References and Notes

1. Honeywell MSDS 14512, Modified Hydrofluoric Acid – 90%
2. W. Schotte, "Fog formation of hydrogen fluoride in air," Ind. Eng. Chem. Res., 26, 300-306 (1987).
3. U.S. Patent 5,654,251, Figure 1.
4. Lange's Handbook of Chemistry
5. The temperature of the 50,000 lb of MHF in the Torrance refinery's Acid Settler Tank is nearly identical, at 105°F. Consent Decree Safety Advisor Steve Maher presented a chart titled "AHF/MHF" which listed "Typical settler temperature 105°F" at the 10/13/2015 City of Torrance Workshop regarding ExxonMobil's use of MHF catalyst.
6. R. Muralidhar, G.R. Jersey, F.J. Krambeck, S. Sundaresan, "A two-phase release model for quantifying risk reduction for modified HF alkylation catalysts," J. Hazardous Materials, 44, 141-183 (1995).
7. D. Blewitt, J. Yohn, R. Koopman, and T.C. Brown, 1987, "Conduct of Anhydrous Hydrofluoric Acid". International Conference on Vapor Cloud Modeling, Boston MA, Nov 2-4, (1987).

Torrance Refining Company

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: TRAA's MHF and HF Vapor Pressure Graph is based on theoretical data and unsupported assumptions

- **Patent US 5,654,251 states the following in support of low concentrations of MHF Additive being effective in depressing vapor pressure:**

  *"One **important function** of the presence of the sulfone component in the composition is its vapor pressure depressant effect upon the overall catalyst composition. Therefore, to take advantage of the vapor pressure depressant effects of the sulfone compound, it is **desirable to utilize the sulfone in the catalyst mixture in an amount in the range of from about 2.5 weight percent to about 50 weight percent**. In the situation where both vapor pressure depression and improved catalytic activity and selectivity are desired, the **composition that works best in the alkylation of olefins has less than 30 weight percent sulfone.**" **[Emphasis added.]***

- **TRAA source: Harpole article based on theoretical data rather than actual data**
  - Harpole uses AHF data that is **NOT** relevant/applicable to MHF
  - Harpole does **NOT** include the other components of MHF – water and ASO
  - Harpole's theory is **NOT** supported by testing
  - Harpole's conclusion is **NOT** supported by a third party review

Reference

- *Patent US 5,654,251*

Torrance Refining Company

MYTH - TRAA Slide 12: TRAA's MHF and HF Vapor Pressure Graph is based on actual data

TRAA "Case Against MHF" Jan 4, 2017 – Slide 12

MHF and HF Vapor Pressure

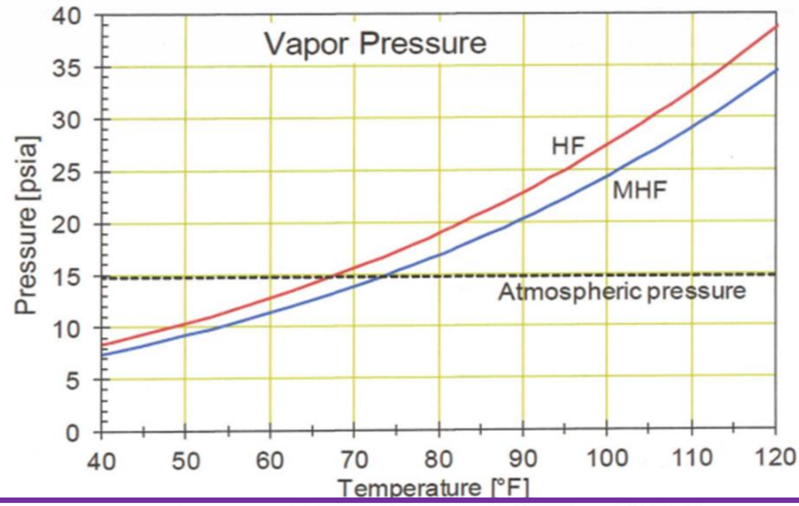

Figure 1 – Vapor Pressure of HF and MHF

George Harpole, Ph.D., Chief Engineer, Northrop Grumman Aerospace Systems, Aug 27, 2016, "HF and MHF – Equivalent Ground Hugging Fog Hazards." <http://bit.ly/2ck2l8G>.

Sally Hayati, TRAA

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Referenced Article
by TRAA Science Panel Member

HF and MHF – Equivalent Ground Hugging Fog Hazards

George Harpole, Ph.D., 10/21/2016

MHF (modified hydrogen fluoride) with 10% additive (10% by weight sulfolane)[1] is almost the same as pure, anhydrous hydrogen fluoride (HF). Only 1.8% of the moles or molecules are sulfolane, and 98.2% are HF. The molecular weight of HF is 20 g/mol, and that of sulfolane is 120 g/mol – so molecules of sulfolane weigh 6 times as much. Adding sulfolane to HF increases the mixture molecular weight, so increases the gas density when it evaporates in a release. Still, to exceed the effective density of air (molecular weight 29 g/mol), at least 37% by weight sulfolane (9% mole fraction) would be needed – if evaporation resulted in only pure gas. Instead, when liquid HF (or MHF) is released and mixed with air, there is substantial cooling by evaporation and by depolymerization, such as $(HF)_6 \rightarrow 6HF$ [2]. The air/HF mixture temperature drops below the dew point, and a fog is formed by condensation of water vapor in the air. Then, the effective density exceeds that of air, so this becomes a ground hugging fog. The water aerosol warms up again as it absorbs the HF. But, water has low volatility, so the fog persists.

Vapor pressure is the only fluid property related to the claimed relative safety of MHF. Added sulfolane reduces the MHF vapor pressure relative to that of pure HF. Raoult's law for ideal liquids estimates the vapor pressure as proportional to mole fraction, so about 98% that of pure HF. However, the mixture is not an ideal liquid. Data show the vapor pressure of MHF (with 10% by weight sulfolane) to be 89% of that for pure HF [3]. Vapor pressures of HF [4] and MHF are shown in Figure 1 as functions of temperature. HF (boiling point 67°F) and MHF (boiling point 73°F) are both very volatile. If the MHF were 6°F (3.3°C) warmer, its vapor pressure would equal that of HF.

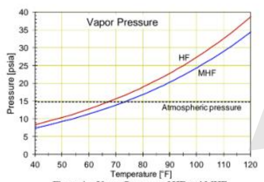

Figure 1 – Vapor Pressure of HF and MHF

In 1986, Lawrence Livermore and Amoco Oil Company conducted what has become known as the Goldfish tests. In each test, 8,300 lb of 104°F (40°C) HF was released in the Nevada desert on a smooth, dry lake bed with about a 10 mph wind. Nitrogen gas above the HF liquid pressurized the tank to about 130 psia. These conditions were selected to match what exists at refineries[5]. However, single vessels at the Torrance refinery, for example, hold six times as much HF (50,000 lb).

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References and Notes

1. Honeywell MSDS 14512, Modified Hydrofluoric Acid – 90%
2. W. Schotte, "Fog formation of hydrogen fluoride in air," Ind. Eng. Chem. Res., 26, 300-306 (1987).
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6. R. Muralidhar, G.R. Jersey, F.J. Krambeck, S. Sundaresan, "A two-phase release model for quantifying risk reduction for modified HF alkylation catalysts," J. Hazardous Materials, 44, 141-183 (1995).
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Torrance Refining Company

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: TRAA's MHF and HF Vapor Pressure Graph is based on theoretical data and unsupported assumptions

- **1995 Patent referenced in Harpole's article does <u>NOT</u> support his theoretical assumption that Flash Atomization will occur**
- **Referenced 1995 research summary article actually states: *"This aerosolization tendency can be significantly reduced by introducing an additive, which reduces the vapor pressure thereby eliminating flash atomization."***
  - Harpole ignores this and all data that supports testing and MHF efficacy

<u>References</u>

- *Patent US 5,654,251*
- *R. Muralidhar, G.R. Jersey, F.J. Krambeck, S. Sundaresan, "A two-phase release model for quantifying risk reduction for modified HF alkylation catalysts," J. Hazardous Materials, 44, 141-183 (1995)*

MYTH - TRAA Slide 13: Patent table refers to MHF: "Appearance is 'fuming,' like HF's. NOT SAFE."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 13

MHF with ≤ 20% additive is described as "fuming," like HF

MHF's 1992 European patent submitted by Phillips (Mobil's co-developer) test data is given for additive concentrations from 20% to 50%. No data is given for any lower concentration, since that was too low to confer any "safety" advantage over HF.

Example	1	2	3	4
Catalyst	HF	HF/ Sulfolane (80/20)	HF/ Sulfolane (60/40)	HF/ Sulfolane (50/50)
Appearance	Fuming	Fuming	Liquid	Liquid

Phillips Petroleum Co, 1992, Patent EP 0796657 B1, "Alkylation catalyst containing hydrofluoric acid & a sulfone."

Example column 2 is MHF with 20% additive (Sulfolane) and 80% HF. 71ºF.

- Appearance is "fuming," like HF's. NOT SAFE. MHF w/ 10% additive will be even more like HF.
- ≥ 40% additive appears as a liquid. SAFER, although some HF does get airborne.

Yet Phillips notes, "Alkylate quality… decreased with further Sulfolane" above 20% and isoparaffin/olefin alkylation *ceased* for additive concentration > 50%. MHF isn't viable.

Sally Hayati, TRAA 13

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: TRAA's "Table A" includes partial information - NOT the complete, original table, which shows ALL alkylate properties

- **Actual table from patent shows additional information and refers to alkylate product rather than MHF; TRAA misleadingly indicates the table refers to MHF**

Table A

Example	1	2	3	4
Catalyst	HF	HF/ Sulfolane (80/20)	HF/ Sulfolane (60/40)	HF/ Sulfolane (50/50)
Appearance	Fuming	Fuming	Liquid	Liquid
Alkylate Product wt %				
C_5-C_7	5.5	4.7	5.9	8.3
C_8	88.1	89.3	85.5	79.9
C_9+	6.4	6.0	8.6	11.8
TMP/DMH	9.2	9.4	7.5	6.5
Olefin Conv., %	99.9	100	98.0	98.8

EP 0 796 657 B1

**Note: Green box added to original image from Patent to highlight specific point referenced/discussed*

Torrance Refining Company

MYTH - TRAA Slide 13: Patent says “Appearance is ‘fuming,’ like HF’s. NOT SAFE.”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 13

MHF with ≤ 20% additive is described as “fuming,” like HF

MHF’s 1992 European patent submitted by Phillips (Mobil’s co-developer) test data is given for additive concentrations from 20% to 50%. No data is given for any lower concentration, since that was too low to confer any “safety” advantage over HF.

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Yet Phillips notes, “Alkylate quality… decreased with further Sulfolane” above 20% and isoparaffin/olefin alkylation *ceased* for additive concentration > 50%. MHF isn’t viable.

Sally Hayati, TRAA 13

**Note: Purple boxes added to TRAA’s original image/text to highlight specific points referenced/discussed*

Torrance Refining Company

FACT: <u>NOTHING</u> in Patent EP 07 96657 B1 says MHF was fuming and is not safe or viable

- **Patent EP 07 96657 B1 does <u>NOT</u> define fuming and the mentioning of fuming in the patent application is <u>NOT</u> indicative of Rainout from MHF**
- **Sample analyzed in "Table A" on TRAA's slide is alkylate product - <u>NOT</u> acid**
  - Patent lines [0038] [0039] state:

    "Samples of liquid and gas products were analyzed."
- **"Table A" on TRAA's slide includes partial information - <u>NOT</u> the patent's complete, original table, which shows <u>ALL</u> alkylate properties**
- **Patent line [0040] states: "*performance was comparable to pure HF*"**
  - This patent statement refers to alkylate product quality, including appearance, from a mixture of 20 wt% Additive and 80 wt% HF
  - **<u>NOT</u>** that the MHF acid had the same appearance as pure HF
- **Subsequent patents quantify Rainout in great detail**

<u>Reference</u>

- *Patent EP 0796657 B1*

MYTH - TRAA Slide 13: “No data is given for any lower concentration [MHF with ≤ 20%], since that was too low to confer any safety advantage over HF.”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 13

MHF with ≤ 20% additive is described as “fuming,” like HF

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Sally Hayati, TRAA 13

****Note: Purple boxes added to TRAA’s original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: Patent US 5,654,251 presents data that the Additive was tested at concentrations as low as 2.5 wt% Additive

- **Patent EP 0796657 B1 <u>is silent</u> on whether lower concentrations were tested**
  - 1992: One of Mobil's earliest MHF patents
  - Patent purpose: Test pilot plant alkylate quality comparing MHF to HF catalysts

- **Patent US 5,654,251 used in Harpole's Article and referenced by TRAA indicates that Additive concentrations as low as 2.5 wt% <u>were tested</u>**
  - Harpole and TRAA ignored this information - see Slide 39

- **TRAA misrepresents the patent and ignores data that supports MHF efficacy**

<u>References</u>

- *Patent EP 0796657 B1*
- *Patent US 5,654,251*

Torrance Refining Company

MYTH - TRAA Slide 13: " ≥ 40% additive appears as a liquid. SAFER, although some HF does get airborne."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 13

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MHF's 1992 European patent submitted by Phillips (Mobil's co-developer) test data is given for additive concentrations from 20% to 50%. No data is given for any lower concentration, since that was too low to confer any "safety" advantage over HF.

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Sally Hayati, TRAA

13

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: Patent refers to an alkylate sample - <u>NOT</u> an MHF acid sample

- **Patent EP 0796657 B1 does <u>NOT</u> state that at >40% Additive concentration the acid appears as a liquid**
  - Sample analyzed in “Table A” on this slide is alkylate - **<u>NOT</u>** an acid sample
  - Patent does **<u>NOT</u>** state that some MHF becomes airborne at Additive >40%

- **Patent line [0040] states *“performance was comparable to pure HF”***
  - This patent statement refers to alkylate product quality, including appearance, from a mixture of 20 wt% Additive and 80 wt% HF
  - **<u>NOT</u>** that the MHF acid had the same appearance as pure HF – see Slide 43

<u>Reference</u>

- *Patent EP 0796657 B1*

MYTH – TRAA Slide 13: "Phillips notes, 'Alkylate quality… decreased with further Sulfolane' above 20% and isoparaffin/olefin alkylation *ceased* for additive concentration > 50%. MHF isn't viable."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 13

MHF with ≤ 20% additive is described as "fuming," like HF

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Sally Hayati, TRAA 13

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: Patent shows MHF is effective and a viable technology

- **Patent EP 0796657 B1 line [0041] states:**
  "*Alkylate quality increased slightly upon adding 20 wt% Sulfolane to HF and then decreased with further sulfolane dilution. Activity for isoparaffin/olefin alkylation was <u>NOT</u> observed above about 50 wt% sulfolane in HF." (Emphasis added)*

- **Patent line [0040] also states:**
  "Performance diminished slightly upon adding 50 wt% sulfolane to HF. A 40/60 HF/Sulfolane catalyst showed no activity for alkylation."

- **TRAA misrepresents the patent and ignores data that supports MHF efficacy**

<u>Reference</u>

- *Patent EP 0796657 B1*

Torrance
Refining Company

MYTH - TRAA Slides 7, 8 and 14: "MHF is 90% HF"; Acid is delivered with 10% Additive

TRAA "Case Against MHF" Jan 4, 2017 – Slide 7

Honeywell Material Safety Data Sheet for MHF reveals what the additive is.
http://bit.ly/21T6yAt

Component	CAS-No.	Weight percent
Hydrogen fluoride	7664-39-3	90.00%
Tetrahydrothiophene 1,1-dioxide	126-33-0	10.00%

Chemical Book, Sulfolane Basic information, ***Sulfolane CAS = 126-33-0***

Valero Wilmington Refinery RMP 2014: MHF 10% Sulfolane to reduce HF vapor

Valero adopted the ReVAP brand of MHF (developed by Mobil/Phillips, now owned by Honeywell) in 2005

TRAA "Case Against MHF" Jan 4, 2017 – Slide 14

MHF is 90% HF

-Plus 10% vapor suppressant additive Sulfolane-

REF: George Harpole, Ph.D., Chief Engineer at Northrop Grumman Aerospace Systems, Aug 27, 2016, "HF and MHF – Equivalent Ground Hugging Fog Hazards." <http://bit.ly/2ck2l8G>.

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TRAA "Case Against MHF" Jan 4, 2017 – Slide 8

"Trade Secret" Found in the Public Domain

-Additive concentration used is 10%-

SOURCE 1: Torrance Refinery Safety Advisor Project, Steve Maher, "Evaluation of MHF Alkylation Catalyst (Analysis of proposed additive concentration changes)," 10/1999

– This report reveals that the additive concentration was reduced in 1998. It is unknown if it was reduced again later.

SOURCE 2: Honeywell MHF Material Safety Data Sheet (MSDS). The monopoly manufacturer of MHF.
<http://bit.ly/21T6yAt>

- Hydrofluoric acid 90.00% (also 85%)
- Sulfolane (THT) 10.00% (also 15%)

SOURCE 3: Honeywell via PBF

- A range of 10-15% is given, so it is clear the concentration used is 10%, Otherwise, Honeywell would say just 15%

WHAT IS MODIFIED HYDROFLUORIC (MHF) ACID?

- Modified Hydrofluoric Acid (MHF) is HF that contains an additive that lowers the volatility of the original compound
  - ✓ Reduces risk of exposure in the event of an MHF leak or spill
- The MHF used at the Torrance refinery is designed to reduce the volatility, or vapor potential, of hydrofluoric acid and features an additive that can reduce the volatility by 60 to 90 percent
  - ✓ The MHF delivered to the refinery contains the industry standard of approximately 10 to 15 percent concentration of this additive

SOURCE 4: Valero Wilmington Refinery Risk Management Program Report 2014 (adopted same MHF in 2005)

Worst-Case Toxic Scenarios

Physical State	Gas liquified by pressure
Model Used	SLAB Model
Passive Mitigation - Other	10% sulfolane additive to reduce the HF to form an aerosol on release under pressure to atmosphere. "Diffuser" or Barrier around flange.
Confidential Business Information	No

SOURCE 5: City of Torrance Refinery Workshop October 2015. Mayor P. Furey stated MHF = 90% HF + 10% additive

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****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: MHF is delivered at 85 wt% HF and 15 wt% Additive

- **The positive effect of MHF results from the combination of four components: Additive, Water, Acid Soluble Oil, and Hydrocarbons**
- **Torrance Refinery MHF Alkylation Unit acid concentration**

December 2016	Monthly Average	Minimum	Maximum
HF wt%	80.0	78.0	82.5
Additive wt%	7.0	5.5	8.5
Acid Soluble Oil wt%	3.0	2.2	5.2
Water wt%	3.0	2.4	3.0
Hydrocarbons wt%	7.0		
Airborne Reduction Factor %	55		

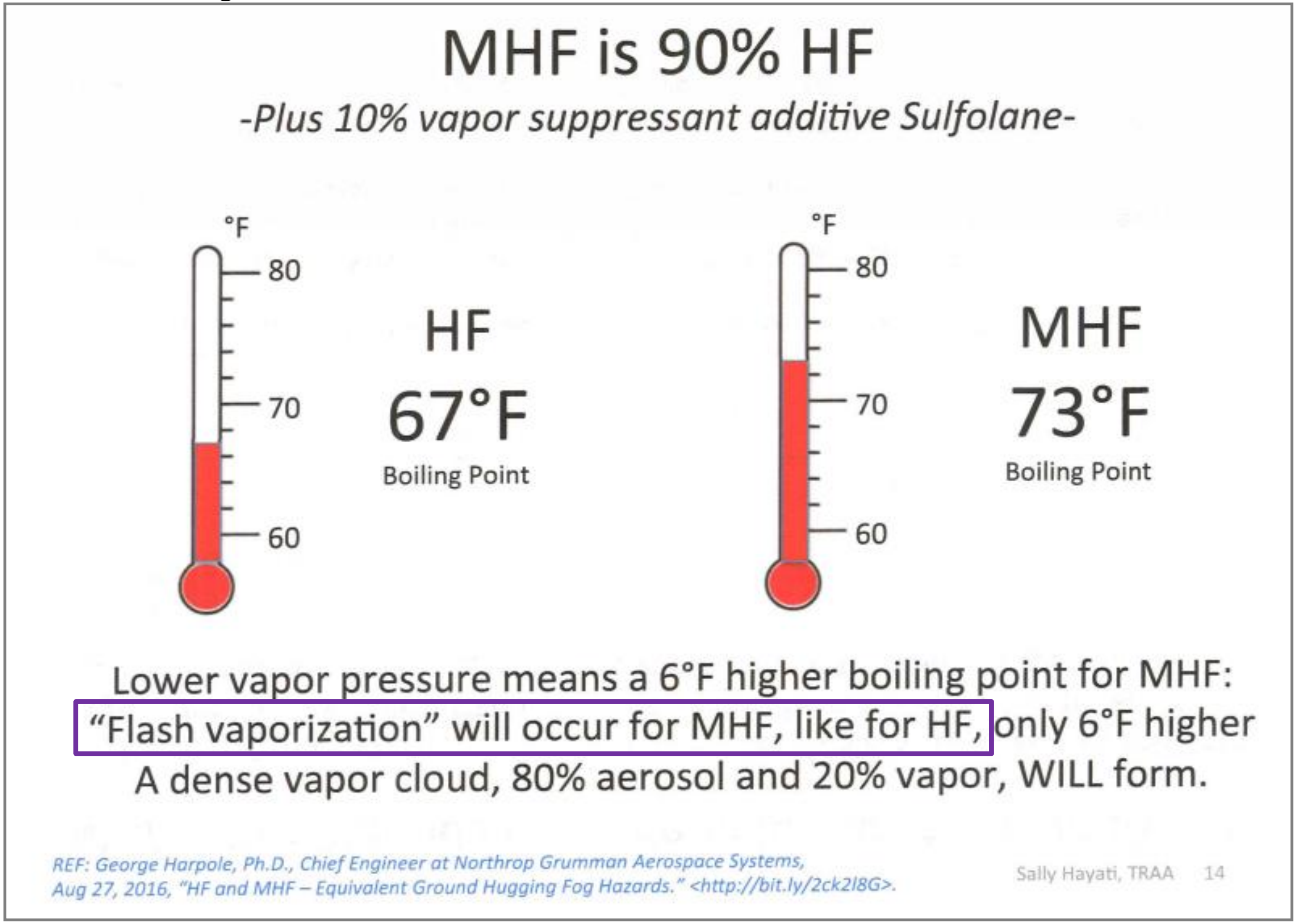
References

- *Bill of Lading from Honeywell for delivered MHF*
- *December 2016 monthly ARF email submission to Torrance Fire Department*

Torrance Refining Company

MYTH - TRAA Slide 14:
“Flash vaporization will occur for MHF, like for HF”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 14



****Note: Purple box added to TRAA’s original image/text to highlight specific points referenced/discussed***

FACT: Hydrogen bonding prevents MHF from flash atomizing

- **Hydrogen bonding of the Additive resists vaporization of HF and prevents large-scale aerosoling of the released liquid**
- **Experiments showed that the addition of the Additive causes a significant fraction of the released HF to fall on the ground as liquid rainout**
- **Testing in 1992 and 1994 showed inclusion of Additive eliminates Flash Atomization of HF associated with a jet release**
- **Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F**
- **NO technical data or test data supports TRAA's claim that the boiling point of MHF is 6ºF higher than HF and that flash atomization will occur**
- **TRAA's source - Harpole Article - is based on theoretical data**
  - 1995 Patent referenced in article does **NOT** support the theoretical assumption that Flash Atomization will occur
  - **No** test data supports Harpole Article and was **NOT** reviewed by third party

References

- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*
- *ReVAP Tutorial page 7*
- *Patent US 5,654,251*

Torrance Refining Company

Chapter 7: Airborne Reduction Factor & Societal Risk Index

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MYTH - TRAA Slide 16: “MHF w/ <20% additive was never TESTED.” - ARF extrapolated

TRAA “Case Against MHF” Jan 4, 2017 – Slide 16

Airborne Acid Reduction Factor (ARF)

-Safety Advisor’s 1999 Report-

IV.A.12 - ARF Extrapolations Beyond Designated Concentration Range

- Figures IV.A.12-1a & IV.A.12-1b [REDACTED] illustrate the correlation of Airborne Reduction Factor (ARF) to the wt% HF and the wt% additive within the process. Figure IV.A.12-1b clearly illustrates that significant gains in ARF are achieved at relatively low additive concentrations, and that the effectiveness curve for additional additive flattens out.
- Ref. 5 [REDACTED] identifies the following equation “used to predict” Airborne Reduction Factor (ARF) (“the fraction of the total HF in the catalyst mixture that remains “bonded” to the additive portion of the mixture & rain-out with it after release”) “for mixtures varying from {REDACTED } wt% to approximately {REDACTED } wt% HF”

WHY “EXTRAPOLATE”? Because MHF w/ <20% additive was never TESTED.

WHY NOT? No “safety” advantage is gained over HF at MHF additive levels <30%.

Estimates of the ARF achieved by 10% additive can best be derived from MHF test data, not from equations written in 1998 to justify an additive reduction by a factor of three.

Sally Hayati, TRAA 16

*Note: Purple box added to TRAA’s original image/text to highlight specific points referenced/discussed

FACT: MHF at <20 wt% was tested – Airborne Reduction Factor (ARF) was <u>NOT</u> extrapolated

- **Additive range of concentrations ≤20 wt% were tested in 1992 and 1994**
  - Tests confirmed the Additive increases ARF even at low concentrations
- **Unit ARF calculated as a function of acid, Additive, water, reactor temperature**
  - Validated rainout model has good agreement with ARF test results
- **Figure 5 shows ARF tested at different concentrations at the same temperature**
- **Figure 4 shows ARF tested at different temperatures and concentrations**

Figure 5

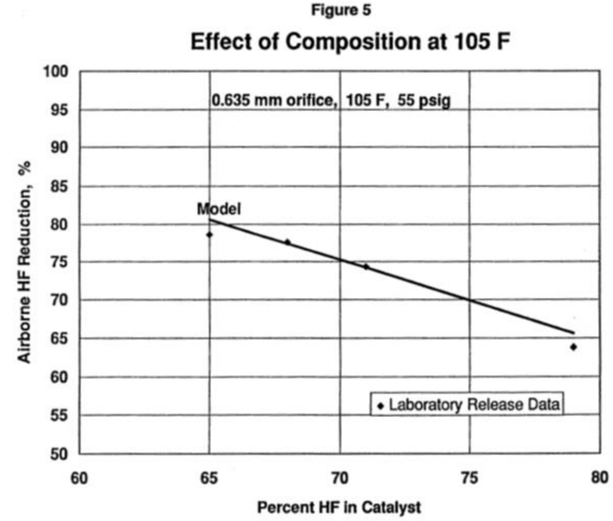
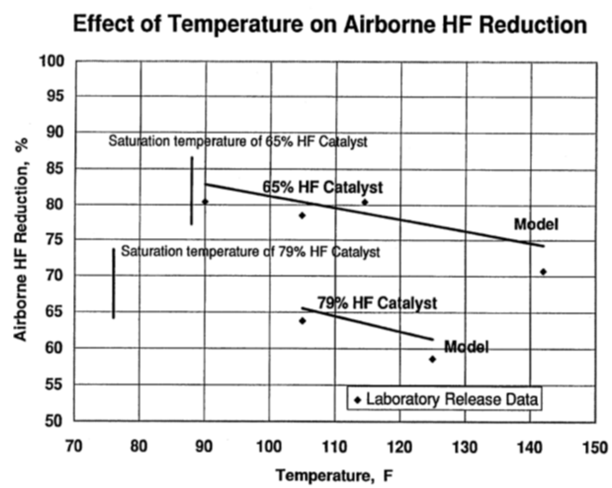


Figure 4



<u>**Reference**</u>

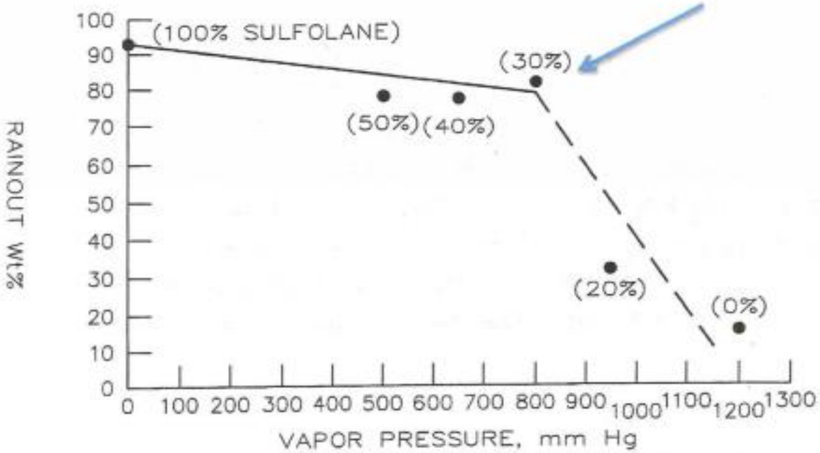
- *DAN 96M-0144 - Small Scale HF/Additive Tests at MHF Design Conditions*
- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*
- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA, and MHF Releases*
- *DAN 93M-0408 - HF/Additive Release Tests at Quest*

Torrance Refining Company

MYTH - TRAA Slide 17: "MHF ARF was Determined by Lab Testing" - ARF the sole function of vapor pressure

TRAA "Case Against MHF" Jan 4, 2017 – Slide 17

MHF ARF was Determined by Lab Testing



Phillips Patent US 5534657, 1995, "Isoparaffin-olefin alkylation."

SAFETY ADVISOR'S 1999 REPORT:

Figure IV.A.12-1b [REDACTED] clearly illustrates that significant gains in ARF are achieved at relatively low additive concentrations, and that the effectiveness curve for additional additive flattens out.

This data curve and graph show that for additive concentrations < 30%, ARF falls precipitously.

10% additive gets no higher than 10% ARF, but that falls to zero when temperatures exceed the critical superheat value and flash atomization occurs.

Table C

Conditions: about 50 psig (0,45 MPa), 90°F (32°C), 0.635 mm orifice diameter.			
Example No.	Sulfolane Wt %	TMP Wt %	Rainout, wt % by Material Balance
8	60	*	
9	50		76
10	50	69	76
11	50		82
12	40	73	76
13	40		78
14	30	78	81
15	20	80	32

* Less than 5 wt %.

Phillips Patent EP 0796657 B1, 1992,. "Alkylation catalyst containing hydrofluoric acid and a sulfone."

Sally Hayati, TRAA 17

Torrance Refining Company

FACT: ARF is <u>NOT</u> a function of Vapor Pressure

- **ARF is a function of four components: Additive, Water, Acid Strength, and Reactor Temperature – see slide 59**
    - Process chemistry safety of MHF is measured by ARF, a “release behavior” property of MHF
- **ARF represents the amount of HF that remains a liquid relative to the amount of HF potentially released to the atmosphere after a release**
    - The larger the ARF, the less potential for HF to become airborne
- **Referenced patent by TRAA is based on early MHF testing in 1992 and was filed using preliminary data**
    - Data in the chart and table are both from the 1992 testing
        - ❑ Patent updated in 1995 only with corrosion test data
    - Data had a large degree of uncertainty during early testing due to testing apparatus
        - ❑ Before the relationship between the Additive and aerosolization had been rigorously explored
    - Considerable research and testing was performed subsequent to the patent application
        - ❑ Completed large scale tests at Quest and additional small scale tests with improvements to apparatus
        - ❑ Tested additional parameters to prove MHF efficacy – see slide 59 for an example

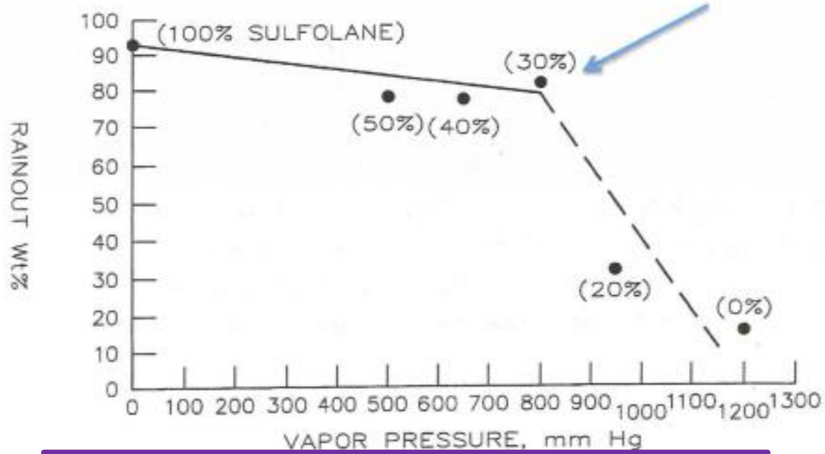
<u>References:</u>

- *Patent US 5,534,657*
- *Consent Decree Safety Advisor’s Report, October 1999, p 1B.A-34*
- *DAN 96M-0144 - Small Scale HF/Additive Tests at MHF Design Conditions*
- *DAN 93M-0408 - HF/Additive Release Tests at Quest*

MYTH - TRAA Slide 17: "This data curve and graph show that for additive concentrations below < 30%, ARF falls precipitously."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 17

MHF ARF was Determined by Lab Testing



Phillips Patent US 5534657, 1995, "Isoparaffin-olefin alkylation."

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SAFETY ADVISOR'S 1999 REPORT:

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10% additive gets no higher than 10% ARF, but that falls to zero when temperatures exceed the critical superheat value and flash atomization occurs.

Sally Hayati, TRAA 17

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance
Refining Company

FACT: There are multiple errors in the analysis, assumptions, and conclusions on TRAA's Slide 17

- **Referenced patent by TRAA was a study of MHF alkylate product quality**
  - **NOT** an in-depth study of MHF Rainout and ARF
- **Error: Top table in TRAA’s slide measures “Rainout” - NOT ARF**
  - MHF Rainout is different than ARF
    - Rainout - The act of a substance forming a liquid and dropping or “raining” to the ground. “Rainout percent” refers to the percentage of released liquid HF which remains as a liquid due to rainout
    - ARF - Airborne Reduction Factor **-** The percent reduction in airborne HF as compared to an unmitigated AHF release
- **Rainout and ARF associated with MHF were extensively established through rigorous lab and field testing**
  - Research and testing conducted in 1992, 1994, and 1996
- **AQMD Quote - “Addendum, Mitigated Negative Declaration, Mobil Modified Hydrogen Fluoride Conversion Project”, p. 2 - July 9, 1997**
  - “The experimental testing indicated that the addition of the Mobil additive to HF was an effective method for reducing or elimination the amount of aerosol formed during a release.”

References

- *Patent US 5,534,657*
- *DAN 96M-0144 - Small Scale HF/Additive Tests at MHF Design Conditions*
- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*
- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA, and MHF Release*

MYTH - TRAA Slide 17: ARF "… falls to zero when temperatures exceed critical superheat and flash atomization occurs."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 17

MHF ARF was Determined by Lab Testing

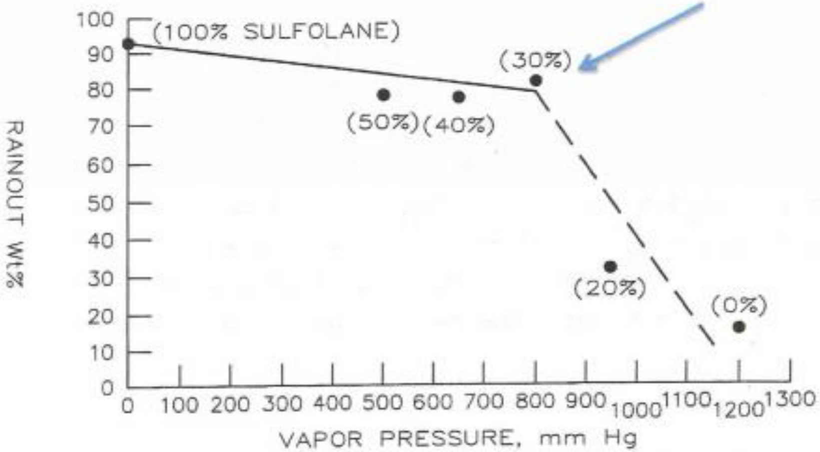

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Figure IV.A.12-1b [REDACTED] clearly illustrates that significant gains in ARF are achieved at relatively low additive concentrations, and that the effectiveness curve for additional additive flattens out.

This data curve and graph show that for additive concentrations < 30%, ARF falls precipitously.

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Conditions: about 50 psig (0,45 MPa), 90°F (32°C), 0.635 mm orifice diameter.			
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* Less than 5 wt %.

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10% additive gets no higher than 10% ARF, but that falls to zero when temperatures exceed the critical superheat value and flash atomization occurs.

Sally Hayati, TRAA 17

***Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed**

Torrance Refining Company

FACT: No flash atomization occurs for superheated MHF

- **Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F**
- **Testing showed operating temperatures as high as 140ºF do not significantly degrade MHF Rainout performance, and Flash Atomization was not apparent**
  - MHF critical superheat was not exceeded at temperatures tested
  - MHF does not flash atomize at vapor pressures above atmospheric pressure while at temperatures below critical superheat
    - Release dominated by jet hydrodynamic drop break up and droplet vaporization
  - Testing proved lower Additive concentrations had ARF that was above 50% - see slide 59
- **Testing in 1992 and 1994 showed inclusion of Additive eliminates Flash Atomization of HF associated with a jet release**
- **AQMD Quote - Wilmington Refinery Alkylation Improvement Project, Final EIR Chapter 2, p. 2-7 - SCH #20030536, certified December 16, 2004 regarding Valero's MHF Project**
  - "The modified HF catalyst reduces acid vapor pressure sufficiently to suppress the usual flash atomization process of hydrofluoric acid, causing most of the acid to fall to the ground as an easily controlled liquid and reduces the potential for off-site consequences of an accidental HF release."

References

- *DAN 96M-0144 - Small Scale HF Additive release tests at MHF design conditions*
- *DAN 95M-0874 - HF Airborne HF Reduction estimates*

Chapter 8: Using Barriers to Enhance Safety

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MYTH - TRAA Slide 18:
Table accurately reflects patent reference

TRAA "Case Against MHF" January 4, 2017 - Slide 18

MHF Lab Tests used Barriers & Collection Plates w/H2O

Mobil's Proprietary Barrier technology

HF/Additive Tests — Pressure: 140 psig

HF concentration wt %	Additive wt %	Temperature °F.	Impact Plate & Pad Yes/No	Rainout wt %
50	50	110	N	64
50	50	110	Y	99
66	34	90	N	53

Patent US5286456, 1992, Mobil Oil Corporation, Containment of an Aerosolable liquid jet,

- "Proprietary mitigation technologies" used in MHF testing (SA '95 report, V-2 (p 92))
  - Barriers to enhance droplet fallout (liquid separator)
  - Water in collection trays to act as a liquid pool evaporation suppressant
- MHF performance claims significantly less when those technologies weren't used.
  - But Alky unit 1994 design did not include any of either measure, the 1998 unit just a few barriers.
- 1994 Stipulation and Order: MHF should achieve 65% ARF using 30% additive.
  - Mobil's 1993 data table indicates that 34% additive achieves only 53% rainout (~ARF) without proprietary barriers (impact plate & pad). 30% would get less.

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: TRAA altered the Table in this patent by inserting an Additive wt% column and deleting a test number row

HF/Additive Tests					
Test No	HF concentration wt %	Pressure psig	Temperature °F.	Impact Plate & Pad Yes/No	Rainout wt %
34	50	140	110	N	64
36	50	140	110	Y	99
33	66	140	90	N	53
37	69	140	90	Y	94

Note: This is the original table from the patent

Green boxes highlight specific points discussed on slide 71

References

- *Patent US 5,286,456*
- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*

MYTH - TRAA Slide 18:
"MHF Lab Test used Barriers & Collection Plates w/H20"

TRAA "Case Against MHF" January 4, 2017 - Slide 18

MHF Lab Tests used Barriers & Collection Plates w/H2O

Mobil's Proprietary Barrier technology

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HF concentration wt %	Additive wt %	Temperature °F.	Impact Plate & Pad Yes/No	Rainout wt %
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66	34	90	N	53

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Sally Hayati, TRAA 18

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: There are multiple errors in TRAA analysis, assumptions, and conclusions on TRAA Slide 18

- **TRAA altered the table in Slide 18 from the original patent document**
  - Deleted data – test number column
  - Deleted data – entire last row in original table – test no. 37
  - Deleted the “Pressure, psig” column
  - Manipulated data - Additive wt% column added using a font type that mimics the original patent
  - Incorrectly assumed Additive concentrations in patent table were “1 - HF”
  - See actual table from patent on slide 69

- **Collection trays containing water referenced in the patent were used to capture and prevent HF from escaping the test apparatus**
  - Collection trays were <u>NOT</u> considered barriers for testing purposes
  - Three collection trays filled with water in lab testing apparatus were <u>NOT</u> meant to mitigate or evaluate barrier effectiveness
  - 1998 MHF design had many barriers as stated in the Safety Advisors 1999 Report

- **The patent’s author references the deleted data featured in Test No. 37: “Tests 36 and 37 of the Table, installation of an impact plate covered with steel mesh demister pads at approximately 3 feet the orifice increased rainout by about 35-40%.”**

<u>Reference</u>

- *Patent US 5,286,456*

MYTH - TRAA Slide 18: "Mobil's 1993 data table indicates that 34% additive achieves only 53% rainout (~ARF)" - "1994 Stipulation and Order: MHF should achieve 65% ARF using 30% additive."

TRAA "Case Against MHF" January 4, 2017 - Slide 18

MHF Lab Tests used Barriers & Collection Plates w/H2O

Mobil's Proprietary Barrier technology

HF concentration wt %	HF/Additive Tests: Additive wt %	Temperature °F.	Pressure: 140 psig: Impact Plate & Pad Yes/No	Rainout wt %
50	50	110	N	64
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Sally Hayati, TRAA 18

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: There are multiple errors in the analysis, assumptions, and conclusions on TRAA Slide 18

- **1995 Court-order stated 65% ARF - <u>NOT</u> an Additive percentage**
  - The initial Consent Decree was 65% ARF with ~19 wt% Additive
  - 1998 MHF Alkylation Unit had **<u>ALL</u>** barriers in place
    - Flange shrouds, settler vessel bellypans, and pump barriers
- **TRAA's altered table in slides 68, 70 and 72 is from Mobil Patent US 5,286,456 <u>filed in 1992 NOT 1993</u>**
- **Patent US 5,286,456 references the Large Scale Tests conducted at Quest**
  - Additive concentration in Quest tests was **<u>NOT</u>** "1-HF" as TRAA misleadingly represents
  - Quest test measured MHF Rainout <u>NOT</u> ARF
- **TRAA misstates the actual intent of Patent US 5,286,456**

<u>References</u>

- *Patent US 5,286,456*
- *DAN 93M-0408 - HF/Additive Release Tests at Quest*

Torrance Refining Company

MYTH - TRAA Slide 20: "Significant differences between lab test setup and Alky Unit Barriers" and "never tested"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 20

Barriers to Enhance HF Rainout

-Significant Differences between lab test setup and Alky Unit barriers-

	Temp ºF	Additive %	Barrier Distance, in.	% HF Rainout
Tested	89.6	29	40	89-90
Modeled	105.0	10	1 - 3	95.8

- Barrier technology employed in small scale lab performance MHF testing
  - Patent US5286456, 1992, Mobil Oil Corporation, Containment of an aerosolable liquid jet
  - Release orifice diameter: 0.025" (0.635 mm); Flow chamber size: 40" x 12" x 6."
  - End of chamber impingement plate (barrier) covered by steel wool to minimize splashing
  - 3 collection trays filled with water at chamber bottom to suppress vaporization
- 1998 alky unit barrier configuration very different from lab setup
  - Releases from 2-inch holes in the open air, not from .025" holes in a small chamber
  - Higher temp, lower additive %, shorter barrier distance, no steel wool, no H2O
  - **Barriers only "protect" bottom acid settler tanks (3"), acid circulation pump seals (1")**
  - Clear polymer flange pipe shrouds: so poorly conceived Mobil stopped claiming credit
- The alkylation unit configuration performance never tested, just simulated
  - Software model used had known weaknesses with unquantified inaccuracies

Sally Hayati, TRAA 20

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: There are multiple errors in TRAA's analysis, assumptions, and conclusions on Slide 20

- **1992 Patent US 5,286,456 references lab apparatus used for testing different HF concentrations, <u>NOT</u> the Torrance Refinery MHF Alkylation Unit barriers**
  - TRAA misrepresents patent's intent and subject matter
- **Table referenced in TRAA's slide is <u>NOT</u> included in Patent US 5,286,456**
  - TRAA created this table - contains erroneous data with no sources cited
    - Additive percentage not included in original patent
  - HF Rainout associated with the Additive is accurate as shown
  - Barrier effectiveness at short distances (< 1 foot) and current MHF Alkylation Unit operating conditions (105ºF) were tested, not modeled, during the Small Scale Tests
- **Testing proved that MHF Additive coupled with barriers effectively prevents Flash Atomization and increases Rainout**
- **Safety Advisor's October 1999 Report found the ARF for Torrance Refinery's MHF Alkylation Unit increased from 65% in 1995 (MHF-AUA Chemistry) to 89% in 1999 (MHF-AUA chemistry + Barriers)**

<u>**References**</u>

- *Patent US 5,286,456*
- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*
- *DAN 96M-0144 - Small Scale HF Additive Release test at MHF design conditions*

Torrance Refining Company

MYTH - TRAA Slide 20: “Significant differences between lab test setup and Alky Unit Barriers" and "never tested"

TRAA “Case Against MHF” Jan 4, 2017 – Slide 20

Barriers to Enhance HF Rainout

-Significant Differences between lab test setup and Alky Unit barriers-

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  - Software model used had known weaknesses with unquantified inaccuracies

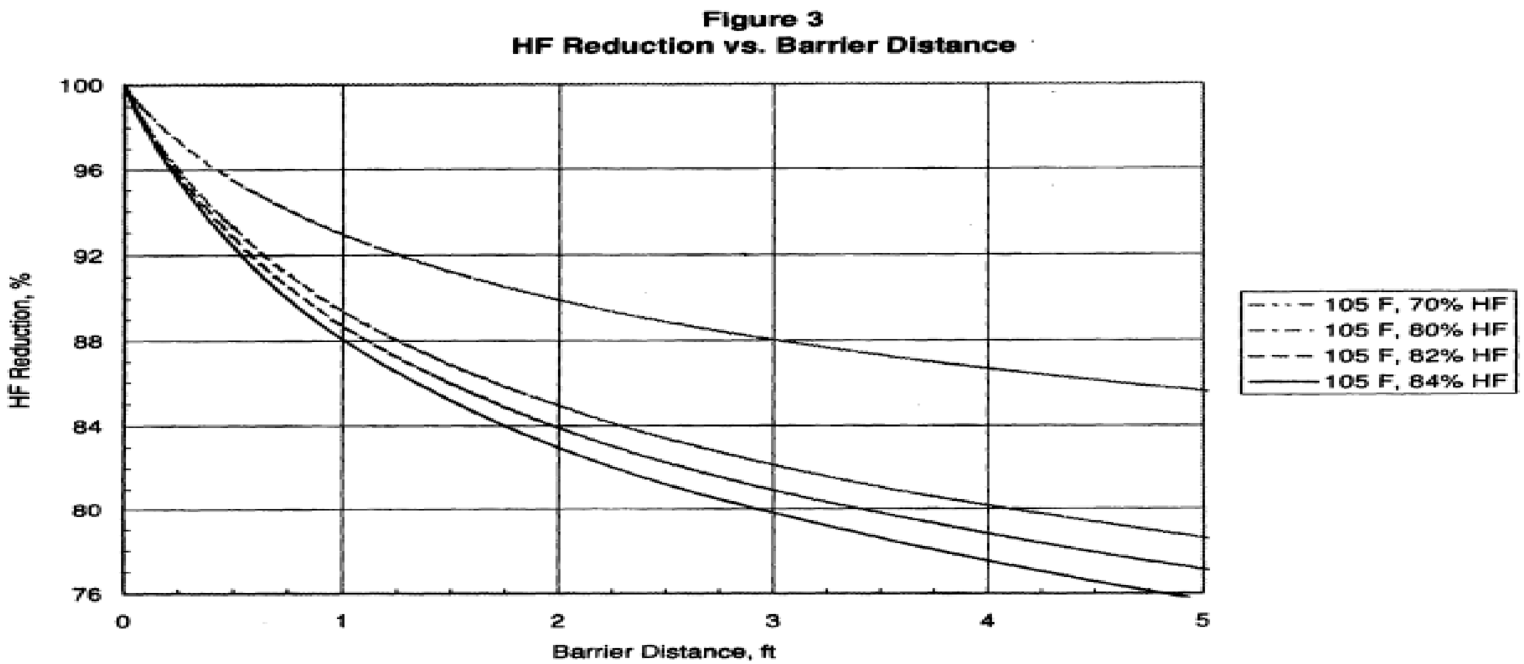
Sally Hayati, TRAA

20

****Note: Purple boxes added to TRAA’s original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: Testing showed barriers are effective and confirmed ARF data



- **Figure shows barrier effectiveness over distances less than one foot provides greater than 90% ARF**

<u>**Reference**</u>

- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*

MYTH - TRAA Slide 20: "Mobil stopped claiming credit" for pipe flange shrouds

TRAA "Case Against MHF" Jan 4, 2017 – Slide 20

Barriers to Enhance HF Rainout

-Significant Differences between lab test setup and Alky Unit barriers-

	Temp ºF	Additive %	Barrier Distance, in.	% HF Rainout
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Sally Hayati, TRAA 20

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: “Mobil DID claim credit for pipe flange shrouds”

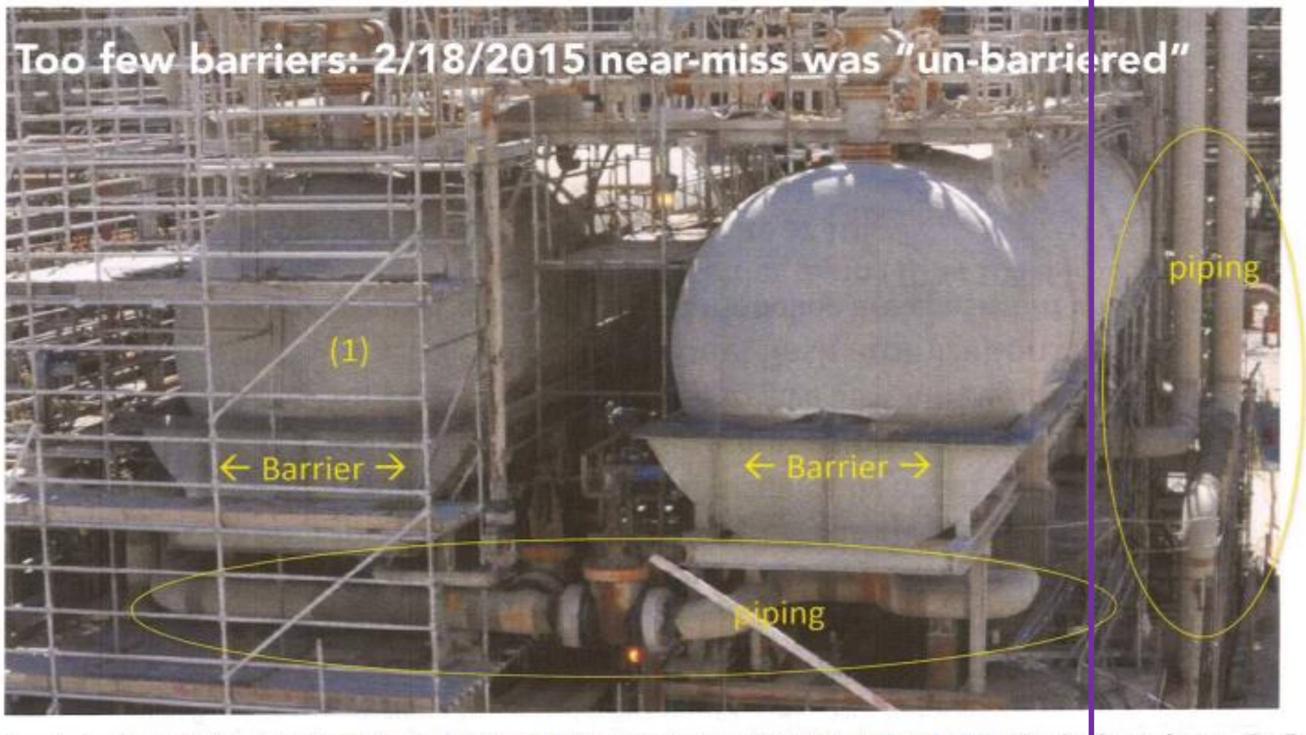
- **Mobil claimed credit for pipe flange shrouds after testing in 1997 proved their effectiveness**
    - Barrier testing in 1992 occurred before flange barriers were developed
- **Flange barrier testing simulated large catastrophic leak on 15 different types of barriers**
    - Shroud material tested and proved compatible with MHF
    - Current MHF Alkylation Unit flange shrouds pressure-tested annually with TFD present
        - Shrouds pass annual test at 250 psig and continue functioning as designed
- **All barriers, including pipe flange shrouds, are used in QRA calculations to determine SRI**
- **Torrance MHF Alkylation Unit Operators monitor the integrity of all barriers daily**
    - TFD notified if a barrier is not fully functional
- **Steel mesh pad installed in flange barrier outlets diffuse liquid flow to minimize splashing**

References

- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*
- *DAN 98M-0699 - Cold Flow Experiments to develop Flange Barriers for the Torrance MHF Unit*
- *TFD Chief Dumais’ presentation at the Torrance City Council - TORC Workshop on February 28, 2017*

MYTH – TRAA Slide 21: "MHF would form a gas and flash out of the tank from a breach anywhere, including the top"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 21



CSB's photo of alkylation unit Acid Settlers (1) and (2), each containing 50,000 lb. of MHF plus hydrocarbons. On Feb. 18, 2015, an 80,000 lb. piece of the ESP crashed feet from tank (2). ExxonMobil claims their settler tank is impervious. But piping isn't. ExxonMobil claims MHF couldn't escape even if a hole were made in the tank top because acid settles to the bottom. Thus the apron barrier. But at Texas City Marathon refinery in 1987, 65K lb. of HF were released after falling equipment broke a 2" pipeline above the liquid level. The SA says the typical settler temperature is 105°F. MHF's boiling point is 73°F. MHF is "liquid under pressure." MHF would form a gas and flash out of the tank from a breach anywhere, including the top. Approximately 80% of released MHF would be an aerosol and 20% vapor.

Sally Hayati, TRAA 21

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: Liquid at the top of the Settler is primarily hydrocarbons that would auto-refrigerate if Settler were breached

- **Both Torrance acid settlers are 2" thick carbon steel vessels**
  - MHF resides at the bottom of the settler below the settler barrier
  - If a settler is breached, liquid hydrocarbons would auto-refrigerate
  - Release from settlers above barriers would be ~98 wt% hydrocarbons and ~1.5 wt% HF
    - Material would be quickly contained and suppressed by safety systems
- **Comparing MHF settler leak to the 1987 Marathon HF incident is misleading, inappropriate, and creates unwarranted fears**
  - Marathon leak was a vapor release of HF-AUA, **NOT** MHF
  - No fatalities
- **Myth: TRAA claims exposed piping to right of settlers in slide 80 contains MHF**
  - Fact: Image shows out-of-service cooling water pipes - **NO** threat of MHF release
- **1992 and 1994 testing showed HF Additive eliminates Flash Atomization of HF associated with a jet release**
  - Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F

References

- *UOP Design Process Flow Diagram (Heat & Material Balance)*
- *DAN 95M-0874 (MHF Airborne HF Reduction estimates)*

Torrance Refining Company

MYTH - TRAA Slide 22: "Barriers Won't Work as Claimed … SW [software] could not model flash atomization."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 22

Barriers Won't Work as Claimed

- 2-phase software model used to estimate performance
  - based on hydrodynamics of jet releases & thermodynamic equilibrium
  - "A two phase release model for quantifying risk reduction for modified HF alkylation catalysts," R. Muralidhar, Mobil, 7 April 1995, Journal of Hazardous Materials 44 (1995) 141-183, <http://bit.ly/2hNYvXz>.
- SW model was never validated against the different alky unit setup
- Safety Advisor admitted that this model …
  - was accurate only for a barrier distances exceeding 3 ft
  - didn't account for "increased splashing" at 1-3" barrier distance
  - "Overpredicted" ARF for shorter barrier distance by about 6%
- 89% is the ARF Mobil assumed for every release obstructed by any barrier.
  - "fudge factor" for each case was chosen to give 89% ARF, w/ no justification
- Most importantly: the SW could not model flash atomization.
  - Mobil & SA ('99 report, p. xiv): data and modeling are consistent with no aerosolization at'98 concentration and settler temp (10%, 105ºF)
  - But MHF with 10% additive will flash atomize at 105ºF

Sally Hayati, TRAA

22

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: Testing proves barriers work - agreement exists between models and experimentally measured ARF

- **Rainout Model predictions for ARF at short distances show steep increase toward 100% airborne reduction**
- **Rainout Model is based on “first principles” and appears to over-predict ARF at distances less than one foot, while predictions for 3 feet and beyond are accurate**
  - Reasoning: liquid hitting a target at close range drops to the ground with some splashing
  - First principles: Hydrodynamics of jet releases and thermodynamic equilibrium
- **ARF at very short barrier distances is only minimally dependent on the acid concentration**
  - HF reduction results primarily from reducing jet release flight time rather than from suppressing vapor pressure
  - Barriers are intended to break the velocity and momentum of the escaping jet stream
- **Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F**

References

- *DAN 96M-0144 - Small Scale HF/Additive Tests at MHF Design Conditions*
- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*
- *DAN 95M-0874 - MHF Airborne HF Reduction estimates*

MYTH - TRAA Slide 22: " 'Fudge factor' for each case was chosen to give 89% ARF"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 22

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  - But MHF with 10% additive will flash atomize at 105ºF

Sally Hayati, TRAA 22

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: 89% ARF based on actual testing with barriers

- **Barriers on the acid settlers are 3” from potential leak source**
  - Model predicts 95.8% ARF for these conditions
  - Conservative 89% ARF was used - adjusted for shorter travel distance of 3” vs 8”

- **ARF was conservatively adjusted to 89% for pipe flange covers at <1” distance**
  - Same ARF as acid settler barriers - also adjusted because collected liquid that drops to ground will experience small amount of vaporization

- **Acid circulation pump seal barriers at 89% ARF are also conservatively estimated**

<u>Reference</u>

- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*

Torrance Refining Company

MYTH - TRAA Slide 23: “Rained out acid rapidly forms a vapor with some droplets”; “Double credit taken for the questionable benefits of this technology”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 23

Barriers Won’t Work as Claimed

- Rained out acid rapidly forms a vapor with some droplets
  - Rained out acid will still becomes airborne although at a slower rate.
  - Some level of cloud concentration reduction is the only benefit.
  - Because of the energy of release, water in pan can’t stop vaporization.
- Double credit taken for the questionable benefits of this technology
  - The MHF test setup included a barrier, wire mesh, plus collection tray w/ water setup
  - Basic MHF ARF claims are valid only with this technology (“impact plate & pad”).
  - 1997 MHF unit design didn’t have barriers; couldn’t have achieved promised 65% ARF.

HF/Additive Tests Pressure: 140 psig

Test No	HF concentration wt %	Additive wt %	Temperature °F.	Impact Plate & Pad Yes/No	Rainout wt %
34	50	50	110	N	64
36	50	50	110	Y	99
33	66	34	90	N	53
37	69	31	90	Y	94

1990: 50% add → 100% rainout

1994: 30% add → 65% rainout

Sally Hayati, TRAA 23

**Note: Purple boxes added to TRAA’s original image/text to highlight specific points referenced/discussed*

Torrance Refining Company

FACT: There are multiple errors in the analysis, assumptions, and conclusions on TRAA Slide 23

- **Double credit is <u>NOT</u> taken - the Additive's hydrogen bonding helps hold MHF in a liquid pool, which minimizes evaporation after Rainout**
  - Tests prove rained out MHF acid does **<u>NOT</u>** "rapidly" form a vapor cloud
  - Flange barriers in the MHF Alkylation Unit do have wire mesh pads

- **Testing in 1992 and 1994 showed inclusion of Additive eliminates Flash Atomization of HF associated with a jet release**

- **If released, rained out MHF will be diluted by water mitigation**

- **AQMD Quote – "Alkylation Improvement Project, Final EIR", Chapter 2, p. 2-7 - SCH #20030536, certified 12/16/04, regarding Valero's MHF project:**
  - "The modified HF catalyst reduces acid vapor pressure sufficiently to suppress the usual flash atomization process of hydrofluoric acid, causing most of the acid to fall to the ground as an easily controlled liquid and reduces the potential for off-site consequences of an accidental HF release."

<u>Reference</u>

- *DAN 96M-0144 - Small Scale HF/Additive Release Tests at MHF Design Conditions*

MYTH - Slide 23:
The table accurately reflects the patent reference

TRAA "Case Against MHF" Jan 4, 2017 – Slide 23

Barriers Won't Work as Claimed

- Rained out acid rapidly forms a vapor with some droplets
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Sally Hayati, TRAA 23

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: This table has been altered from the original Patent document

- **TRAA manipulated the data from the original Patent document**
  - Additive wt% was **NOT** in the original patent shown on Slide 88
    - The column was inserted by TRAA
  - TRAA incorrectly presents Additive concentration as “1 - HF” concentration

- **Torrance HF Alkylation Unit was modified in 1997 to use MHF based on the Court-ordered Consent Decree process - achieved 65% ARF without barriers**
  - Acid strength was ~70 wt% - accurately represented in the patent’s original, unaltered table

Reference

- *DAN 98M-0166 - Effects of Active and Passive Mitigation on AHF, AUA & MHF Releases*

Quantitative Risk Analysis
and the
Societal Risk Index

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MYTH - TRAA Slide 25:
“Quantitative Risk Analysis: a Poor Tool”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 25

Quantitative Risk Analysis: a Poor Tool

- A pretense of more quantitative knowledge than is available
  - approximately 20% of critical pump leaks involve seals/gaskets; but the severity or leak size is unknown. p.40 SA2)
  - Determining potential leakage rates outside of the proposed shrouded/ barriered area. (p.40)
  - Information on low frequency events is scarce due to lack of sharing between companies, no transparency
- No risk weighting
  - Negligible risk contributors (p.39 SA2) are ignored
  - Very low probability is assigned to high consequence releases
  - There should be “risk weighting” for consequences too great to tolerate.
- We are expected to TRUST (Mobil and the Safety Advisor) without VERIFYING. This is not the scientific standard.

FACT: "Quantitative Risk Assessment is an effective tool and industry risk management standard"

- **Quantitative Risk Assessment (QRA) is used throughout industry to improve safety and reliability of equipment / processes**
  - QRA follows Center for Chemical Process Safety (CCPS) guidelines
    - Considered a global scientific standard
  - Torrance Refinery also follows American Petroleum Institute's "Recommended Practice 751 - Safe Operation of Hydrofluoric Acid Alkylation Units"
    - Includes periodic third-party audits and other safety requirements
- **As part of the Consent Decree process, a QRA was conducted to determine if, "MHF (including mitigation) presents no greater risk than Sulfuric Acid alkylation plant producing a comparable amount of alkylate." The QRA:**
  - Provided quantitative estimates of risks
  - Considered broad range of scenarios
  - Applied appropriate allowances for likelihood of occurrence
  - Facilitated comparison of different processes - i.e., MHF vs. Sulfuric Acid
  - Highlighted most effective risk mitigation options - provides layers of protection
- **Leak size and frequency was derived from industry data and modeled in the MHF QRA, which includes a range of release sizes**

References

- *CCPS CPQRA published guideline book*
- *American Petroleum Institute Recommend Practice 751*
- *MHF Alkylation Risk Assessment, October 1994*
- *1998 QRA Report - The Modified Hydrofluoric Acid Process Assessment of the Offsite Risk Impact Associated with Modification/Changes in the MHF Process*

MYTH - TRAA Slide 25: “We are expected to TRUST (Mobil and the Safety Advisor) without VERIFYING.”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 25

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Sally Hayati, TRAA 25

****Note: Purple box added to TRAA’s original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: MHF Alkylation efficacy WAS verified and approved by the Court and Permitted by AQMD

- **Approval of MHF Alkylation followed comprehensive Court-ordered Consent Decree and AQMD permitting processes**
- **Change of Additive concentration and addition of barriers were thoroughly vetted and approved in 1999 through the Court-ordered Consent Decree and involved:**
  - A well respected and experienced Superior Court Judge – Hon. Harry Peetris
  - A Court Appointed independent Safety Advisor – Steve Maher
  - City of Torrance Mayor and Council Members
  - Torrance Fire Department and its independent Safety Consultant
- **1999 Safety Advisor's report concluded:**
  - *"[Our] analysis show that the final operating configuration would provide an improvement to the level of safety to the Community."*
  - The report also found that the ARF for the MHF Alkylation Unit increased from 65% in 1995 (MHF-AUA Chemistry) to 89% in 1999 (MHF-AUA chemistry + Barriers)
- **TRAA documents have <u>NOT</u> been verified – <u>NOT</u> a scientific standard**
- **AQMD Quote – "Alkylation Improvement Project, Final EIR", Chapter 2, p. 2-7 - SCH #20030536, certified 12/16/04, regarding Valero's MHF project:**
  - "The modified HF catalyst reduces acid vapor pressure sufficiently to suppress the usual flash atomization process of hydrofluoric acid, causing most of the acid to fall to the ground as an easily controlled liquid and reduces the potential for off-site consequences of an accidental HF release."

<u>Reference</u>

- *Consent Decree Safety Advisor's Report, October 1999*

Torrance
Refining Company

MYTH - TRAA Slides 26 & 31: “Catastrophic failures such as … earthquakes were never addressed.”; “Earthquakes pose a significant risk of MHF release … with little to no mitigation”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 26

Other SRI Weaknesses

- Catastrophic failures such as rupture of the alkylation reactor or settler due to earthquake, fire, large fallen objects, or terror attack were never addressed
- Claim: MHF w/ 10% additive does not “flash atomize.”
  - It has never been demonstrated, experimentally or using a theoretical model, that flash atomization does not occur with the MHF used in the Torrance Refinery today.
  - Yet all safety claims (MHF & barriers) depend on this
- Mobil’s claim that MHF has a factor of three margin in favor of MHF societal risk estimate compared with sulfuric acid alkylation best estimate shows that the risk analysis is totally invalid .

Sally Hayati, TRAA 26

TRAA “Case Against MHF” Jan 4, 2017 – Slide 31

Earthquakes Pose a Significant Risk of MHF Release

-LARGE AMOUNTS OF MHF COULD BE QUICKLY RELEASED WITH LITTLE TO NO MITIGATION-

- Our region is prone to earthquakes
  - The Newport-Inglewood fault E of refinery, “one of the most dangerous in So CA,” capable of a mag 7 quake.
  - Chance of 6.7 earthquake in So CA w/in 30 yrs. is 97%,
  - Chance of a 7.5 earthquake in So CA w/in 30 yrs. is 37%.
- Refineries are known to be vulnerable to earthquakes
  - 2014 study, SF Bay Area governments found that a 5.0 earthquake on a small local fault could shut down refineries two miles away
  - CDC warns that earthquakes can release HF. Cal OES warns of the danger of natural disasters triggeringindustrial accidents (natechs).
  - The CDC has warned earthquakes can release HF.
- 1990 Torrance court brief pointed out specific vulnerabilities
  - The potential [for] catastrophe at the…refinery…from a significant earthquake… on at least six different [nearby] faults is extreme.
  - Mobil’s…documents…prove that due to the age of the Torrance refinery, its process units are highly congested and don’t meet Mobil's minimum fire and safety standards for between the units.
  - Mobil's own insurers warned of "a domino-type catastrophe should even 1 unit [catch]… fire."
- **Despite seismic improvements, the Safety Advisor admitted**
  - **“a seismic event of sufficient magnitude could result in both a breach & a concurrent failure of one or more mitigation systems.”**

2011, mag 9, 200 mi away, Cosmo Oil Ref, Tokyo

1999, mag 7.5, Tupras Refinery, Turkey

Sally Hayati, TRAA 31

****Note: Purple boxes added to TRAA’s original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: To comply with CalARP, the refinery must be able to withstand an earthquake that occurs once every 2500 years

- **Torrance Refinery conducts a seismic assessment every five years per CalARP**
  - Upgrades are made as recommended by assessment's results
  - Intended to reduce likelihood of release of significant quantities of regulated substances in the event of an earthquake
  - Since the use of MHF in 1997, there has **NOT** been an offsite release of HF
  - Torrance Refinery used HF in the Alkylation Unit without any HF offsite release from 1966 until 1997, a period that includes the Sylmar and Northridge earthquakes

- **Torrance Refinery's QRA includes catastrophic release cases without distinguishing between internal or external release**

- **Consent Decree required Safety Advisor to conduct detailed seismic review**
  - Addressed in multiple locations of the Safety Advisor's reports and presentations
    - ❑ Analysis and report on seismic safety of MHF Unit's final design and construction
    - ❑ Walk-down of MHF Alkylation Unit prior to commissioning and operating

- **MHF Additive and barrier protection provide mitigation for potential releases**
  - Testing shows that the Additive will reduce airborne concentrations of HF and prevent Flash Atomization

References

- *CalARP Seismic Analysis*
- *Safety Advisor Reports May 1995, October 1999 and presentation October 2000*

Torrance Refining Company

MYTH - TRAA Slide 26: “Never been demonstrated, experimentally or using a theoretical model, that flash atomization does not occur with the MHF used in the Torrance Refinery today.”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 26

Other SRI Weaknesses

- Catastrophic failures such as rupture of the alkylation reactor or settler due to earthquake, fire, large fallen objects, or terror attack were never addressed
- Claim: MHF w/ 10% additive does not “flash atomize.”
  - It has never been demonstrated, experimentally or using a theoretical model, that flash atomization does not occur with the MHF used in the Torrance Refinery today.
  - Yet all safety claims (MHF & barriers) depend on this
- Mobil’s claim that MHF has a factor of three margin in favor of MHF societal risk estimate compared with sulfuric acid alkylation best estimate shows that the risk analysis is totally invalid .

Sally Hayati, TRAA

26

*Note: Purple box added to TRAA’s original image/text to highlight specific points referenced/discussed

Torrance
Refining Company

FACT: Testing in 1992 & 1994 showed MHF Additive eliminates Flash Atomization associated with a jet release

- **Testing proved no Flash Atomization was observed for MHF compositions containing as much as 85 wt% HF up to 140°F**

- **Testing in 1992 and 1994 showed inclusion of Additive eliminates Flash Atomization of HF associated with a jet release**
  - The Additive bonds to HF, changing the catalyst's characteristics

- **AQMD Quote – "Addendum, Mitigated Negative Declaration, Mobil Modified Hydrogen Fluoride Conversion Project", p. 2 - July 9, 1997**
  - "The experimental testing indicated that the addition of the Mobil additive to HF was an effective method for reducing or elimination the amount of aerosol formed during a release. The additive is a water-soluble, thermally stable compound that is solid at ambient conditions. In addition, the health data indicate that the additive has very low toxicity and limited health impacts as compared to HF which has more severe health impacts."

<u>Reference</u>

- *DAN 96M-0144 - Small Scale HF/Additive Release Tests at MHF Design Conditions*

Torrance Refining Company

MYTH - TRAA Slide 26: "Mobil's claim that MHF has a factor of three margin in favor of MHF societal risk estimate compared with sulfuric acid … is totally invalid."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 26

Other SRI Weaknesses

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Sally Hayati, TRAA

26

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FACT: Results of 1998 QRA update show that mitigation systems favor MHF Alkylation

- **1998 QRA demonstrated the MHF Alkylation Unit has safety mitigation systems that provide an SRI 24x lower than a Sulfuric Acid Unit of comparable capacity**
  - QRA excluded transportation, regeneration, and incineration of spent Sulfuric Acid
    - When added to QRA, risk from sulfuric acid increases significantly
  - Post-1998 additions: MHF-sensitive flange paint, perimeter HF lasers, additional water mitigation and camera play back, water cannons controls to control room
    - These additional safety measures, if included in the QRA, would further lower the SRI associated with use of MHF vs sulfuric acid

- **QRA results show toxic risks associated with Sulfuric Acid Alkylation are higher than for comparable MHF Alkylation Unit**
  - Both processes were shown to represent very low risk
  - Number of people potentially exposed and evacuation zone area were higher for Sulfuric Acid Alkylation than MHF Alkylation

References

- *MHF Alkylation Risk Assessment, October 1994*
- *Safety Advisor Presentation - MHF vs Sulfuric Acid Alkylation Risk Assessment 1998*
- *1998 QRA Report - The Modified Hydrofluoric Acid Process Assessment of the Offsite Risk Impact Associated with Modification/Changes in the MHF Process*

Chapter 10: Additional Safety Measures and Equipment

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MYTH - TRAA Slide 28: "Emergency systems at best reduce but don't eliminate the impact of a release, -And they may also fail"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 28

COULD EMERGENCY SYSTEMS SAVE THE DAY?

*-FACT: EMERGENCY SYSTEMS AT BEST **REDUCE BUT DON'T ELIMINATE** THE IMPACT OF A RELEASE,*

-AND THEY MAY ALSO FAIL -

1. Water suppression systems can be used to knock down some of the airborne acid
2. Rapid de-inventory systems can dump the acid to other locations so less acid leaks

Industry studies in the 1990s revealed "vulnerabilities and weaknesses" of these so-called "active" HF mitigation systems. That motivated the development of MHF.

- Min 40:1 water to HF ratio needed, difficult and $$$ to cover every angle and location where a release could occur, especially with variable wind direction.
- Best case performance of operational water systems:
  - 80-90% reduction airborne acid. Mobil's goal was 80%.
  - Actual performance is "always worse." (Dr. Koopman)
- Typical field system performance is less than optimal
- Much less effective for serious incidents, high rate leakage
- Require time to activate.
  - 30 sec–1 min is very "quick," usu. takes longer
- Can be damaged by explosions, fire, or earthquakes
- Can fail due to poor maintenance and human error

MHF plus active mitigation measures might reduce impact, but won't "keep us safe"

Sally Hayati, TRAA 28

FACT: Redundant emergency systems are routinely tested, validated, and work as designed

- **Torrance MHF Alkylation Unit includes redundant, active mitigation systems**
  - Water systems
    - Nine water cannons are tested weekly
    - Acid service pumps deluge systems are tested monthly
    - Fixed water sprays on vessels are tested annually
  - Detailed inspection of barriers completed weekly
  - Acid Evacuation System tested monthly
  - Risk Management Prevention Plan (RMPP) interlocks are tested monthly
  - HF sensors tested monthly
  - Acid off-loading system tested prior to every truck delivery
  - Active routine and preventive maintenance Inspection program
  - TFD is invited to witness all testing
  - Operator physically present in unit at all times
- **Testing shows that using MHF catalyst with barriers provides 89% ARF**
  - Active mitigation systems as designed would contain a release on site
- **There have been NO offsite releases since MHF alkylation was introduced in 1997**
- **Global Alkylation experts publically informed AQMD that Torrance MHF Alkylation Unit features the most comprehensive safety systems in the world**

Reference

- *Actual unit configuration, performance and testing*

MYTH - TRAA Slide 28: The Acid Evacuation System (AES) "[usually] takes longer" than one minute to activate

TRAA "Case Against MHF" Jan 4, 2017 – Slide 28

Could Emergency Systems Save the Day?

-Fact: Emergency systems at best ***reduce but don't eliminate*** *the impact of a release,*

-And they may also fail -

1. Water suppression systems can be used to knock down some of the airborne acid
2. Rapid de-inventory systems can dump the acid to other locations so less acid leaks

Industry studies in the 1990s revealed "vulnerabilities and weaknesses" of these so-called "active" HF mitigation systems. That motivated the development of MHF.

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MHF plus active mitigation measures might reduce impact, but won't "keep us safe"

Sally Hayati, TRAA 28

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

FACT: The Alkylation Unit's Acid Evacuation System (AES) has been activated within seconds

- **Example: On February 18, 2015, MHF Alkylation Unit Supervisor on duty activated the Unit's AES system within ten seconds when responding to the ESP incident**
  - Acid settlers emptied within 2 to 3 minutes
  - <u>Entire MHF Alkylation Unit acid inventory was completely emptied within 7 minutes</u>

- **AES has only been activated three times since installation in 1991**

- **Based on these three activations, the acid in the settlers is transferred to the AES in 2 to 3 minutes - removing most of the acid**
  - Remaining acid in the unit will take approximately 3 to 4 minutes more to be transferred to the AES

<u>Reference</u>

- *Actual unit performance*

Torrance Refining Company

Chapter 11: Appropriate Use of EPA "Planning Circles"

Torrance Refining Company

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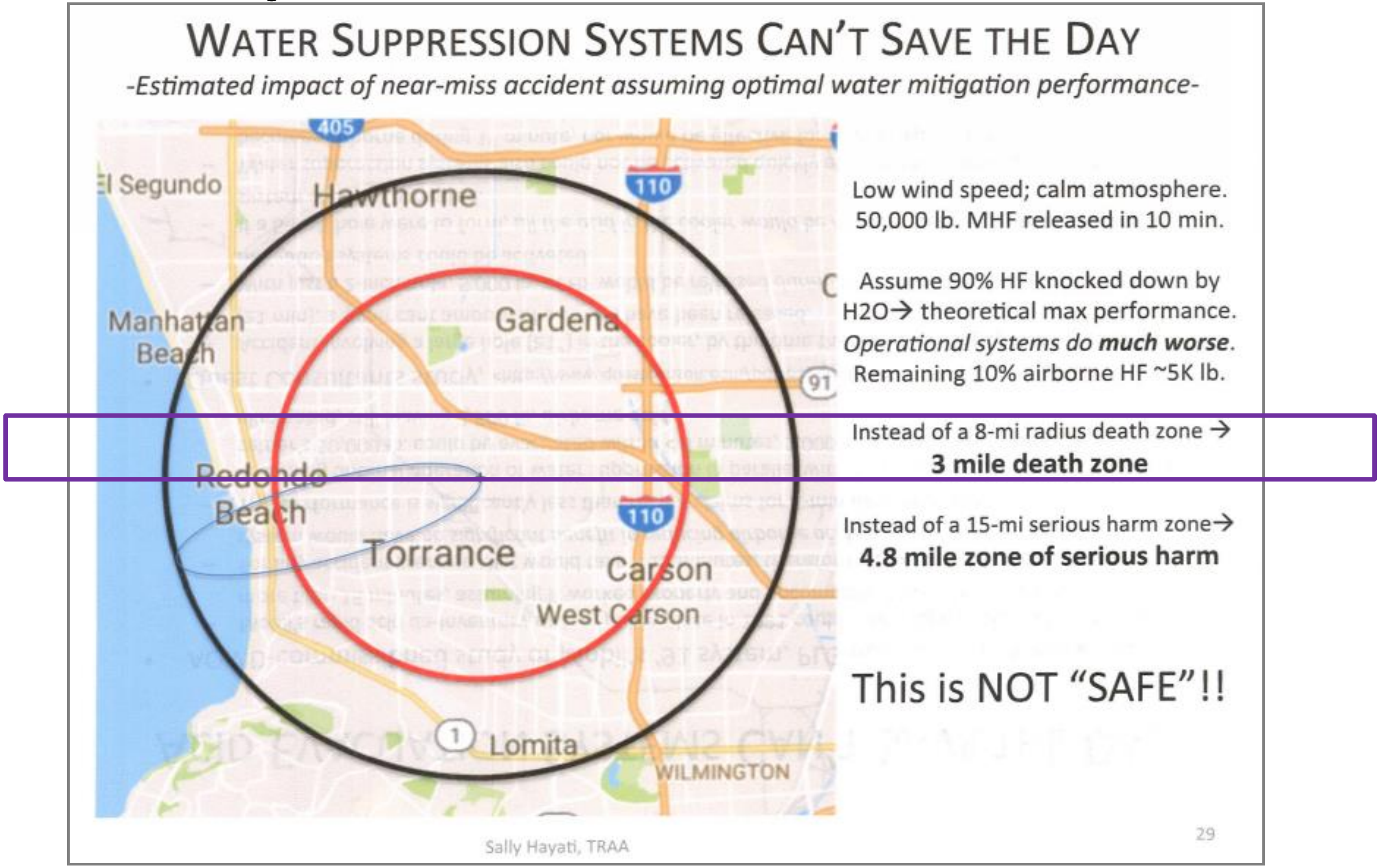
MYTH - TRAA Slide 29: TRAA's interpretation of the RMP follows EPA guidelines and accurately reflects potential community impact

TRAA "Case Against MHF" Jan 4, 2017 – Slide 29



****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: TRAA misrepresents EPA's RMP guidelines for "planning circles"

- **Repeated references to "Circle of Death" and "Death Zone" are misleading and inconsistent with EPA guidelines, creating unnecessary public panic and fear**
  - Misrepresents "planning circles" in EPA's Risk Management Program (RMP)
    - Specifically: Worst-Case Scenario and Off-site Consequence Analysis

- **EPA RMP methodology uses an "endpoint value" referred to as "ERPG-2," developed by the American Industrial Hygiene Association**
  - ERPG-2 represents an "Emergency Planning Area" **NOT** a "Death Zone"
    - ERPG: "Emergency Response Planning Guideline" measures potential exposure
  - Under the Consent Decree process, the Safety Advisor used more conservative ERPG-3 values in analyzing MHF release impacts compared to Sulfuric Acid

- **AQMD Quote – "Alkylation Improvement Project, Statement Of Findings, Statement Of Overriding Considerations, And Mitigation Monitoring Plan", p. 9 - SCH #20030536, certified 12/16/04, regarding Valero's MHF project**
  - "An accidental release of HF could migrate off the Refinery property and expose individuals in the surrounding community. The proposed (MHF) project will substantially reduce the potential hazard impacts associated with an accidental release of HF."

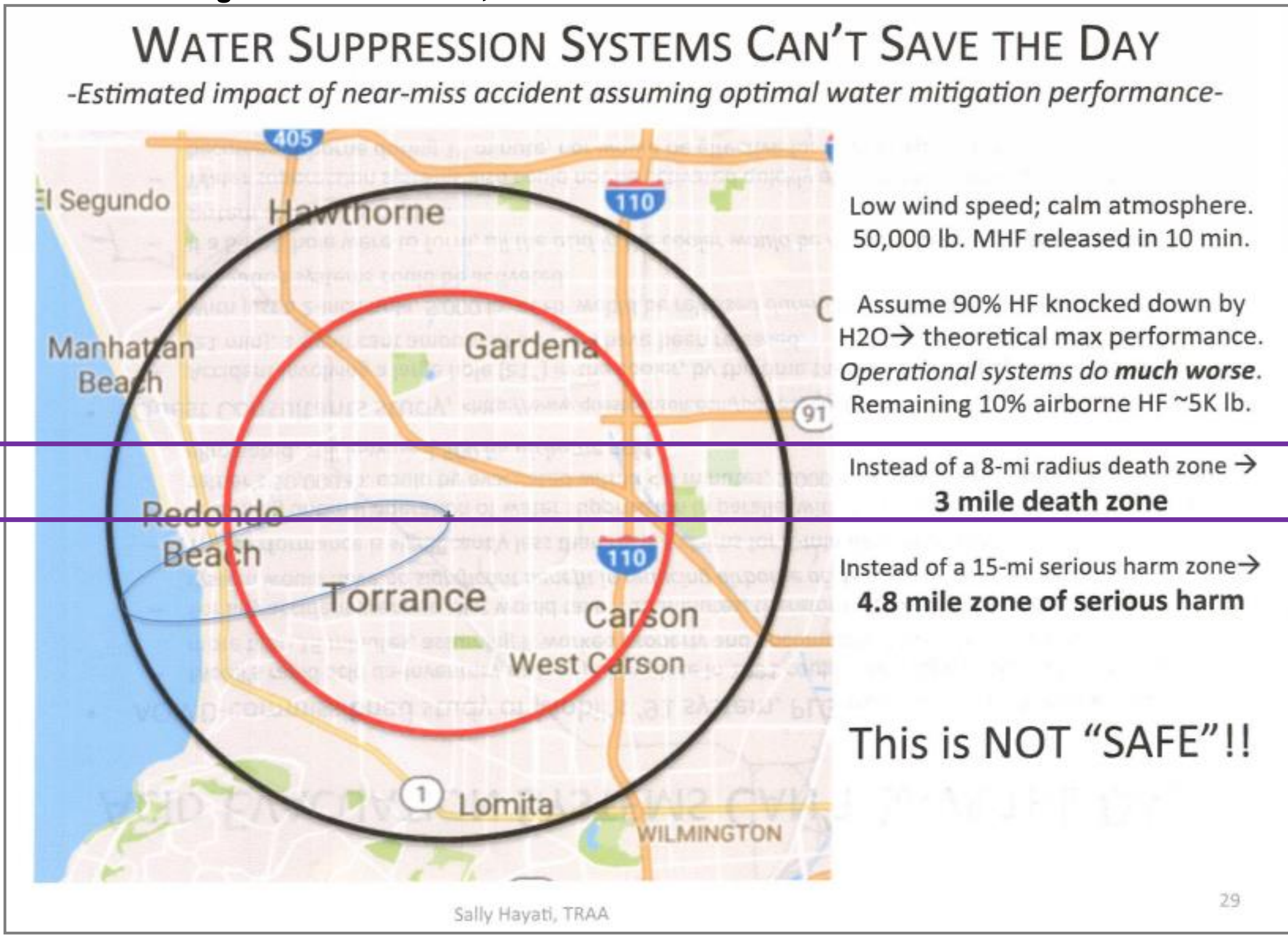
References

- *USEPA, General Guidance on Risk Management Programs for Chemical Accident Prevention EPA 555-B-04-001March 2009*
- *Consent Decree Safety Advisor Report, May 1995*

Torrance Refining Company

MYTH - TRAA Slide 29: TRAA's interpretation of the RMP follows EPA guidelines and accurately reflects potential community impact

TRAA "Case Against MHF" Jan 4, 2017 – Slide 29



*****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: TRAA misrepresents EPA's RMP guidelines for "planning circles"

- **EPA's RMP guidance clearly demonstrate agency's intentions:**
  - *"EPA intends the estimated distances to provide a basis for a discussion among the regulated community, emergency planners and responders, and the public, rather than a basis for any specific predictions or actions."*
  - *"The distance (to endpoint) is intended to provide an estimate of the maximum possible area that might be affected by a catastrophic release from your facility. It is intended to ensure that no potential risks to public health are overlooked, but* ***the distance to an endpoint estimated under worst-case conditions should not be considered a 'public danger zone.' " (Emphasis added.)***
  - EPA also cautions that *"[c]haracterizing data using only worst-case scenarios can be misleading and unnecessarily alarming." See Id*., p. 7.

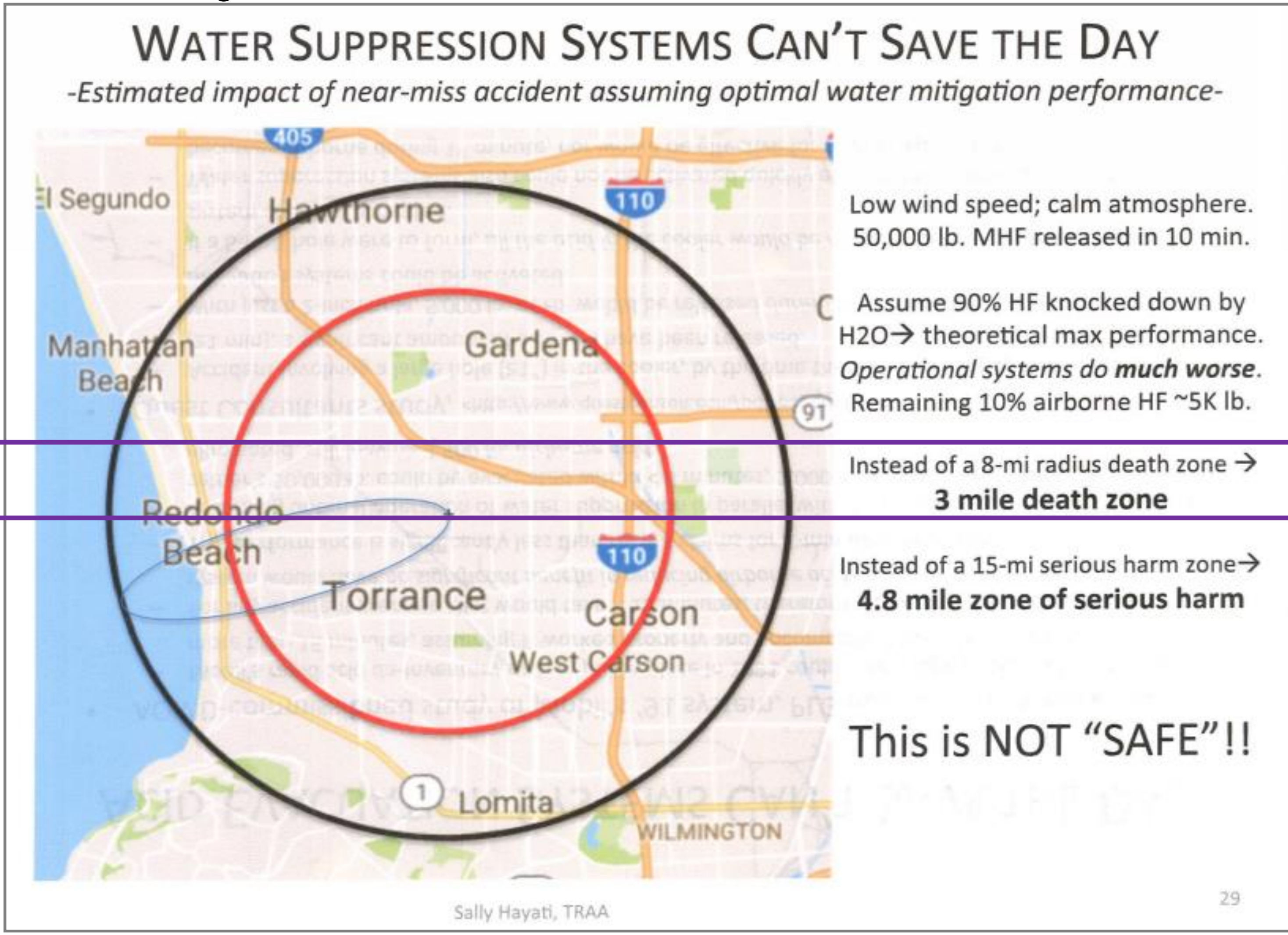
- **EPA RMP guidelines acknowledge the WCS uses unrealistic modeling parameters and is an ultra-conservative, unrealistic scenario:**
  - *"Because the assumptions required for the worst-case analysis are very conservative, the results likely will also be very conservative ... The distance to the endpoint estimated under worst-case conditions should not be considered a zone in which the public would likely be in danger, instead it is intended to provide an estimate of the maximum possible area that might be affected in the unlikely event of catastrophic conditions."*

Reference

- *USEPA, General Guidance on Risk Management Programs for Chemical Accident Prevention EPA 555-B-04-001March 2009*

MYTH - TRAA Slide 29: TRAA's interpretation of the RMP follows EPA guidelines and accurately reflects potential community impact

TRAA "Case Against MHF" Jan 4, 2017 – Slide 29



****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: The Additive and barriers reduce potential airborne concentrations of HF

- **TRAA ignores the proven effectiveness of the Additive and barrier technology**
- **Testing shows the Additive and barriers reduce airborne concentrations of HF**
- **Safety Advisor's 2001 report evaluated benefits of MHF Additive and barrier protection - concluding these contributed to airborne reduction of MHF**
- **AQMD Quote - "Addendum, Mitigated Negative Declaration, Mobil Modified Hydrogen Fluoride Conversion Project", p. 2 - July 9, 1997**
  - "The experimental testing indicated that the addition of the Mobil additive to HF was an effective method for reducing or elimination the amount of aerosol formed during a release. The additive is a water-soluble, thermally stable compound that is solid at ambient conditions. In addition, the health data indicate that the additive has very low toxicity and limited health impacts as compared to HF which has more severe health impacts."

<u>Reference</u>

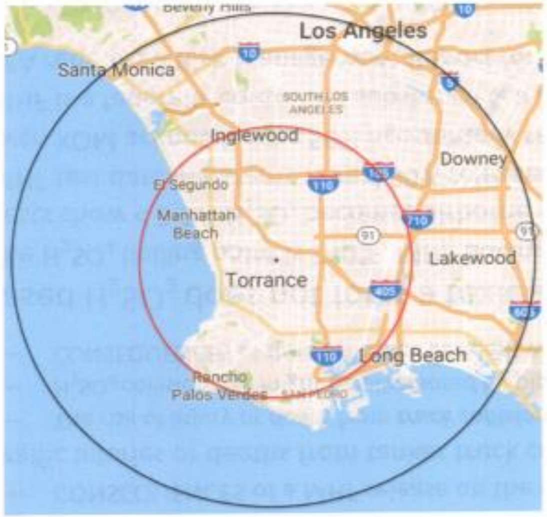
- *Consent Decree Safety Advisor Report, September 2001 - Alkylation Unit Quantitative Risk Assessment Updates*

MYTH - TRAA Slide 36: MHF vs. Sulfuric Acid – RMP Worst-Case Scenario Planning Circles Go Away

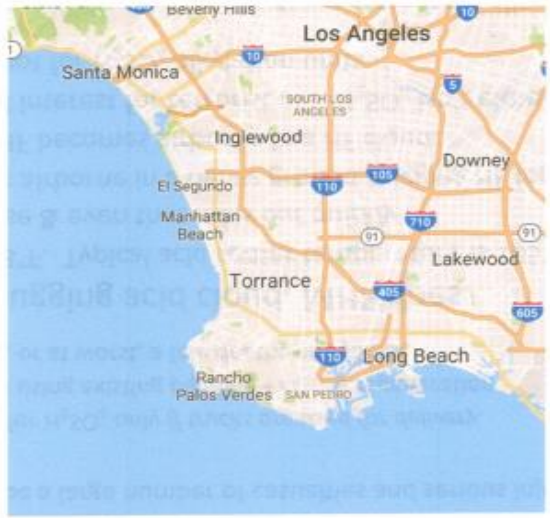
TRAA "Case Against MHF" Jan 4, 2017 – Slide 36

Sulfuric Acid Alkylation

-Far Safer for the Community-



Torrance Refinery MHF Alky unit
Realistic Worst Case Scenario



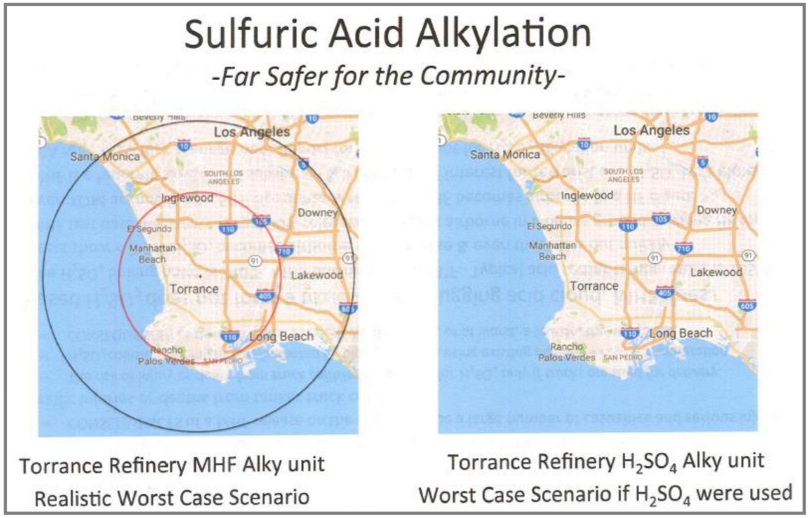
Torrance Refinery H_2SO_4 Alky unit
Worst Case Scenario if H_2SO_4 were used

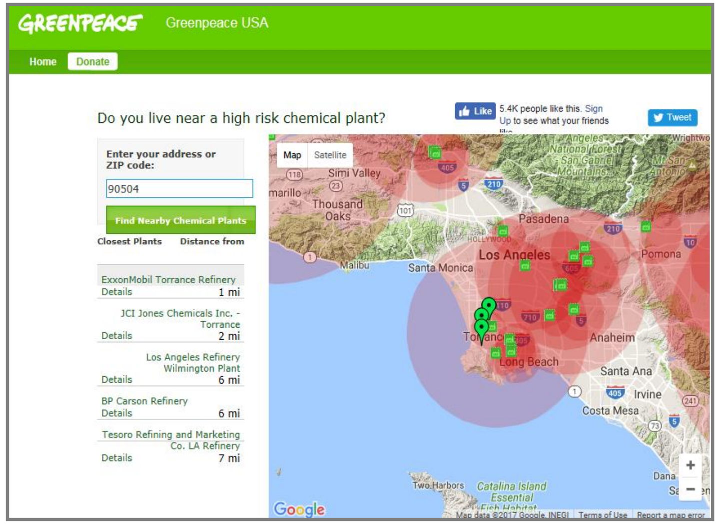
[The] use [of] "modified HF acid" for alkylation is a strategy that I oppose vigorously. This is an approach the majority of the refining industry does not use. There have been good options from the beginning [namely, sulfuric acid] ...There are those in the industry that cling to their belief in "modified HF" and the supporting technology. Most of those advocates either sell the design or license it. ...When all else fails, the advocates for such a strategy resort to the claim that...the two acids are equally safe."
Donald Hall, former refinery manager for the Big West in Bakersfield & Texaco's Los Angeles plant, 2008

**Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed*

Torrance Refining Company

FACT: If Sulfuric Acid Alkylation replaces MHF, the City of Torrance would still be within multiple "planning circles"





- **TRAA is correct - sulfuric acid is not a toxic substance per EPA RMP guidance**
  - Spent sulfuric acid is toxic and listed as a carcinogen by the International Agency for Research on Cancer
- **The RMP Worst-Case Scenario emergency planning area would go away with conversion to a Sulfuric Acid Alkylation Unit**
  - What the TRAA doesn't state is that the "emergency planning area" does not completely go away with conversion to sulfuric acid
- **EPA RMP emergency planning areas do not completely go away**
- **There are many other facilities that require RMPs in Torrance and the Los Angeles basin**

References

- *USEPA, General RMP Guidance - Chapter 4: Offsite Consequence Analysis*
- *http://usactions.greenpeace.org/chemicals/map*

Torrance Refining Company

Chapter 12: Irresponsibly Creating Public Fear and Outrage

The Torrance Refinery Alkylation unit began operating in 1966 and has never had an offsite release

- **1966 - 1997: Hydrofluoric acid - HF**
- **1997 - 2018: Modified Hydrofluoric Acid - MHF**

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MYTH - TRAA Slide: Torrance MHF Alky Unit release will result in an incident like the Bhopal, India 1984 incident

TRAA Presentation Modified Hydrofluoric Acid (MHF) – Wolf in Sheep's Clothing (Nov. 16, 2016, Slide 2)

Ban MHF to Prevent a South Bay Bhopal!

-World's Worst Industrial Disaster-

*Bhopal, India 1984: release of a **toxic volatile gas**, methyl isocyanate*

600K exposed, ≥ 15K died, unknown 100Ks injured, many of whom were permanently impaired.

1989 City of Torrance Public Nuisance Lawsuit against Mobil refinery:

A hydrofluoric acid release "could cause a DISASTER OF BHOPAL-LIKE PROPORTIONS... damage could extend to other areas of LA County...100,000's...could be killed and double that...seriously injured."

THOSE STATEMENTS ARE JUST AS TRUE NOW

Sally Hayati, TRAA 2

***Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed**

Torrance Refining Company

FACT: Photo and content designed to instill fear and outrage

- **Cited incident occurred in India 30+ years ago at a chemical plant that did <u>NOT</u> use MHF and had <u>NO</u> redundant safety mitigation systems**
  - Risk Communication refers to this tactic as using "outrage factors". Examples:
    - ❑ Activists linking graphic images/descriptions of tragedies to a targeted company, facility product, etc., to produce fear and outrage
    - ❑ Using children as victims - TRAA uses images of children playing soccer overcome by gas to make residents fearful
      - ➢ Inciting fear and outrage in residents same as showing RMP "planning circles" as "Circles of Death" or "Death Zones"
    - ❑ Misrepresenting risk is counterproductive when the objective is protecting the community and workforce

- **Quote cited on slide was made before MHF, barriers, and other safety systems were installed and used in the Torrance Refinery Alkylation Unit**
  - Refinery began using MHF and installed additional, redundant safety systems to make the plant safer for workers *and* residents
  - Since the use of MHF in 1997, there has not been an offsite release of HF at the Torrance Refinery

- **AQMD Quote: "*Highly Toxic Chemical to be Phased Out at Valero Refinery, February 7, 2003***
  - *"Modified HF … contains additives that significantly reduce the chemical's ability to form a vapor cloud in the event of an accidental release."*

<u>**Reference**</u>

- *Covello & Sandman - "Risk communication: Evolution and Revolution." 2001*

Chapter 13: Sulfuric Acid Alkylation is a False Choice

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MYTH - TRAA Slides 33, 37, & 40: Conversion to Sulfuric Acid Alkylation H_2SO_4 – would be cheap and easy

TRAA "Case Against MHF" Jan 4, 2017 – Slide 33

Alternatives Exist

-SCAQMD Study of MHF Alternatives agreed with TRAA's recommendations-

- Sulfuric Acid (H_2SO_4)
  - 80% (all but 2) refinery alkylation units in CA use this catalyst
  - A toxic liquid—boiling point 640°F. No dense ground hugging acid cloud.
- Solid Acid Catalyst (SAC)
  - Newer, safe and more environmentally benign
  - Pilot plant has been built in the US
  - Commercial plant in China has successfully operated for one year producing excellent quality alkylate

Conversion cost estimates: \$100M (AQMD)-\$300M + (refinery)

- This is consistent with other mandates to protect public health--

Cost of Electrostatic Precipitator (ESP), \$300M in '08:	\$330M
Cost to repair ESP after 2015 explosion:	\$161M

- Mobil's cost to add mitigation systems, develop MHF, convert the HF unit to MHF: ~\$160M during the late 1980's early 1990's — \$275M

Sally Hayati, TRAA 33

TRAA "Case Against MHF" Jan 4, 2017 – Slide 37

Sulfuric Acid Can Do the Job, Safely

Solid Acid Catalyst (SAC) can also do the job; transition time should be same as H_2SO_4

- Sulfuric acid (H_2SO_4) would eliminate the toxic airborne risk
  - DHS: MHF is chemical of interest to terrorists, H_2SO_4isn't
  - EPA: toxic offsite consequence analysis is required for MHF, not for H_2SO_4
  - Experience: 2011 Motiva Delaware City Refinery H_2SO_4release: a total of 1.1 M gallons spent H_2SO_4 with alky unit hydrocarbons were released. There was not one mention of a vapor cloud in the CSB report. No airborne toxic consequence
- All but 2 CA refineries survive in the same marketplace using H_2SO_4
  - Feedstock identical to Torrance's are processed & same additive is made w/ H_2SO_4
- Half of existing and the vast majority of new US alky units use H_2SO_4
  - 86% of new alkylation units in 1990s chose H_2SO_4
- Studies have been done on HF conversion; R&D not needed.
  - CB&I CDAlky low temperature sulfuric acid process. CDTech study.
    - Major pieces of HF equipment can be retained
  - Stratco Alkysafe Process: low-cost conversion method patented.
    - Phillips and UOP designed HF alkylation units can be converted and expanded into H2SO4 alkylation units with minimum capital expense.
- Sulfuric acid might be piped in using existing pipeline from Carson, and regenerated on site. This eliminates the need for increased truck traffic.
- But the community prefers H_2SO_4 over MHF even if trucks must be used

Sally Hayati, TRAA 37

TRAA "Case Against MHF" Jan 4, 2017 – Slide 40

THE COST OF CATALYST CONVERSION

-Estimates vary-

TO SULFURIC ACID

- \$23M (based on 1995 quote: \$15M) Stratco
- \$24M-\$35M (based on 2006 quote: \$20-30M) Stanford Prof. L. W. Wein
- \$50M-\$166M (based on 2009 quote: \$45M-\$150M) Nat'l Petrochem & Refiners
- \$100M (order of magnitude) AQMD Norton Study of MHF alternatives
- \$180M (based on 1990 quote: \$100M) Mobil
- \$300M for a new (~0.6 x smaller) H_2SO_4 unit. Valero
  - The cost to build a unit twice this size would not be twice the price. "The cost of the conversion from HF alkylation to H2SO4 alkylation is a fraction of that of a grassroots unit as it uses most of the existing equipment." Dupont.

TO SOLID ACID CATALYST (SAC)

- \$64M, based on data provided by Exelus for ExSact SAC
  - Exelus claims the cost of H_2SO_4 conversion is double that for SAC, so \$128M
- \$100M, AQMD Norton Study of MHF alternatives

This is consistent with other mandates to protect public health--

Cost of Electrostatic Precipitator (ESP), \$300M in '08:	*\$330M*
Cost to repair ESP after 2015 explosion:	*\$161M*
Mobil's cost to add mitigation systems, develop MHF, and convert the HF unit to MHF: ~\$160M during the late 1980's early 1990's	*\$275M*

Sally Hayati, TRAA 40

Torrance Refining Company

FACT: No HF / MHF Alkylation Unit has ever been converted to a Sulfuric Acid Alkylation Unit and new unit is extremely expensive

- **There are many technical reasons conversion has never been done**
  - Processing equipment and metallurgy differ between technologies
    - Vessels, piping, and equipment are not interchangeable
    - New grassroots Sulfuric Acid Alkylation Unit would be required
- **April 1, 2017 SCAQMD testimony on conversions incorrect and unfounded**
  - Bay Area: Units originally built as Sulfuric Acid - never converted from HF
  - UK: 4 of 6 refineries are HF Alkylation - 2 others have no Alkylation Units
  - Europe: No Alkylation Units have ever been converted to Sulfuric Acid
- **SCAQMD's Norton Engineering Study cost conversion estimate grossly too low**
  - Failed to consider the cost of acid regeneration and incineration
  - Estimate was based on replacement of reaction section only
  - Failed to consider regulatory and construction costs in Southern California
  - New 30 kbd grass roots units third-party cost estimate is significantly higher
  - DuPont at the AQMD August 23, 2017 Proposed Rule 1410 working meeting confirmed the Norton Study estimates were low and not representative of a new unit in Southern California. DuPont provided the estimate to Norton and was based on Gulf Coast costs and did not include scale up or outside the battery limits
- **Cost estimates from the 1990's and early 2000's are irrelevant to today's cost**
  - Cost today for a new Sulfuric Acid Unit with Regeneration is approximately $900MM

References

- *Norton Engineering Study and presentation at American Fuel & Petrochemical Manufacturers meeting February 2016*
- *Burns and McDonnell Report Brief – Alkylation Study and Estimate July 2017*

MYTH - TRAA Slides 38 & 40: In January 2016 Valero announced plans to build a new sulfuric alky unit – with startup in 2018 – two years with permitting

TRAA "Case Against MHF" Jan 4, 2017 – Slide 38

The Transition Period Should be Minimized

- The Consent Decree mandated HF elimination by 1997. It's past time-

- Consent Decree gave 3 years to construct a MHF or sulfuric acid alky unit: 1994-97. Mobil stated in Feb. 1995 it needed no more than two years to switch to MHF.
- In Jan. 2016 Valero announced plans to build a new 13,000 b/d alkylation unit at its Houston refinery with startup in 2018. That's 2 years allocated, including permitting.
- "To construct a sulfuric acid alkylation unit within the existing Refinery… the existing [HF] unit would have to be shutdown and demolished. This and construction of a new alkylation would require approximately 1 year." Valero, Wilmington, 2004
- The refinery should temporarily operate without alkylation if the transition takes > 3 years
  - Alkylation feeds could be transported to alkylation units elsewhere or (possibly) sold for other purposes.
  - Transportation needs for (prev) alky inputs should be similar to & replace current needs for alky output
  - ExxonMobil accepted and stored crude oil shipments for > 1 year during the shut down. It coped.
- Components of the H_2SO_4 alky unit might be (like the ESP)
  - prefabricated at a safer location inside the refinery, then
  - lifted and transported to the final site for installation

"The module approach [to ESP construction] allowed the project to install piling, foundations and structural steel in parallel with ESP assembly, shortening the construction span significantly."

ESP being moved in 2008 to its final location

Sally Hayati, TRAA 38

TRAA "Case Against MHF" Jan 4, 2017 – Slide 40

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Sally Hayati, TRAA 40

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Torrance Refining Company

FACT: Valero announced its new US Gulf Coast Sulfuric Acid Alkylation Plant project in January 2016, with completion expected in 1H2019

- **Valero is building a new $300 million (MM), 13MBD Sulfuric Acid Alkylation Plant in Texas**
  - Estimate excludes added cost of spent sulfuric acid regeneration and incineration plants
    - Regeneration and incineration keep acid supply constant

- **Basic project designs and permitting processes typically take at least two years**

- **Duration of the permitting process in Southern California is lengthy and indeterminate**

- **Valero project entered detailed engineering, procurement and construction phase**
  - Expected to take longer than three years to complete

- **Torrance MHF Alkylation Unit is ~30MBD, more than 2x larger than Valero's new Texas unit**
  - Regulatory, construction and operating costs are significantly higher in California

- **Replacement cost estimates for building a Sulfuric Acid Alky Unit at Torrance Refinery**
  - Burns & McDonnell: New grass roots unit ~ $600MM
  - Cost of Sulfuric Acid Regeneration and Incineration plants would be an additional ~$300MM
  - Acquisition cost of the Torrance Refinery was $187.5MM

References

- *Valero First Quarter 2016 Results*
- *Burns and McDonnell Report Brief – Alkylation Study and Estimate July 2017*
- *Public Company Records on Refinery Sale and Purchase*

MYTH TRAA Slides 38: A new Torrance Sulfuric Acid unit can be constructed in modules like the ESP

TRAA "Case Against MHF" Jan 4, 2017 – Slide 38

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ESP being moved in 2008 to its final location

Sally Hayati, TRAA

38

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Torrance Refining Company

FACT: A modular approach is irrelevant for a Sulfuric Acid Alkylation Unit at Torrance

- **Equipment required for a processing unit is very different from the Torrance Refinery's FCC ESP, which is an emissions control device**

- **Most processing equipment for a Sulfuric Acid Alkylation Unit cannot be manufactured and constructed modularly like the ESP**
  - Consists of towers, heat exchangers, other pressure vessels, pumps, piping networks, instrumentation, and many other types of equipment
  - There are many long lead items that take years to design/engineer, procure, fabricate, and deliver
    - Long lead items can include pressure vessels, towers, heat exchanges and valves
    - Certain sections could be modularly constructed but would not significantly reduce overall construction time due to long lead items

Reference

- *Construction Fundamentals*

Torrance Refining Company

MYTH -TRAA Slide 37: "Sulfuric Acid might be piped in using existing pipeline from Carson"

TRAA "Case Against MHF" January 4, 2017 - Slide 37

Sulfuric Acid Can Do the Job, Safely

Solid Acid Catalyst (SAC) can also do the job; transition time should be same as H_2SO_4

- Sulfuric acid (H_2SO_4) would eliminate the toxic airborne risk
  - DHS: MHF is chemical of interest to terrorists, H_2SO_4 isn't
  - EPA: toxic offsite consequence analysis is required for MHF, not for H_2SO_4
  - Experience: 2011 Motiva Delaware City Refinery H_2SO_4 release: a total of 1.1 M gallons spent H_2SO_4 with alky unit hydrocarbons were released. There was not one mention of a vapor cloud in the CSB report. No airborne toxic consequence
- All but 2 CA refineries survive in the same marketplace using H_2SO_4
  - Feedstock identical to Torrance's are processed & same additive is made w/ H_2SO_4
- Half of existing and the vast majority of new US alky units use H_2SO_4
  - 86% of new alkylation units in 1990s chose H_2SO_4
- Studies have been done on HF conversion; R&D not needed.
  - CB&I CDAlky low temperature sulfuric acid process. CDTech study.
    - Major pieces of HF equipment can be retained
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Sally Hayati, TRAA 37

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Torrance Refining Company

FACT: There is NO sulfuric acid pipeline from Carson to Torrance

- **Building fresh and spent sulfuric acid pipelines would be virtually impossible in Southern California**
  - Requires acquisition of appropriate rights-of-way and permits through various private property owners, municipalities and regulatory agencies

- **Transportation of spent and fresh sulfuric acid offsite poses additional safety risks to the community**
  - Spent sulfuric acid contains dissolved sulfur dioxide and hydrocarbons
    - Spent solution is corrosive and can be potentially unstable and reactive
  - Concentrated fresh and spent Sulfuric Acid are highly dangerous and produce insidious burns to human flesh
  - Spent sulfuric acid is an Acutely Hazardous material
  - Trucks and railcars have over-pressured to atmosphere in the past
    - Releasing a vapor/liquid mixture can form a hazardous aerosol
    - There would be ~1440 truck shipments per month if regenerated offsite

References

- *EcoServices Plant Representative*
- *MHF Alkylation Risk Assessment, October 1994*
- *1998 QRA Report - The Modified Hydrofluoric Acid Process Assessment of the Offsite Risk Impact Associated with Modification/Changes in the MHF Process*

Torrance Refining Company

MYTH -TRAA Slide 37: "Sulfuric Acid might be piped in using existing pipeline from Carson"

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FACT: There is NO sulfuric acid pipeline from Carson to Torrance

- **Process hazard analysis for an MHF vs. Sulfuric Acid Unit siting decision must consider transportation and regeneration risks**
  - Combined risk may result in a different risk management decision than considering the process risk alone
  - During the Consent Decree process, a comprehensive QRA was conducted to compare the risk of MHF to Sulfuric Acid
    - QRA determined that MHF with mitigation was safer than Sulfuric Acid
    - QRA conservatively omitted Sulfuric Acid transportation and regeneration risks

References

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Chapter 14: Emerging Alkylation Technologies are Unproven

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MYTH - TRAA Slides 33, 37, & 40: Commercially available alternatives to MHF exist for Torrance

TRAA "Case Against MHF" Jan 4, 2017 – Slide 33

Alternatives Exist

-SCAQMD Study of MHF Alternatives agreed with TRAA's recommendations-

- Sulfuric Acid (H_2SO_4)
  - 80% (all but 2) refinery alkylation units in CA use this catalyst
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- Sulfuric acid might be piped in using existing pipeline from Carson, and regenerated on site. This eliminates the need for increased truck traffic.
- But the community prefers H_2SO_4 over MHF even if trucks must be used

Sally Hayati, TRAA 37

TRAA "Case Against MHF" Jan 4, 2017 – Slide 40

THE COST OF CATALYST CONVERSION

-Estimates vary-

TO SULFURIC ACID

• \$23M	(based on 1995 quote: \$15M)	Stratco
• \$24M-\$35M	(based on 2006 quote: \$20-30M)	Stanford Prof. L. W. Wein
• \$50M-\$166M	(based on 2009 quote: \$45M-\$150M)	Nat'l Petrochem & Refiners
• \$100M	(order of magnitude)	AQMD Norton Study of MHF alternatives
• \$180M	(based on 1990 quote: \$100M)	Mobil
• \$300M for a new (~0.6 x smaller) H_2SO_4 unit.		Valero

  - The cost to build a unit twice this size would not be twice the price. "The cost of the conversion from HF alkylation to H2SO4 alkylation is a fraction of that of a grassroots unit as it uses most of the existing equipment." Dupont.

TO SOLID ACID CATALYST (SAC)

- \$64M, based on data provided by Exelus for ExSact SAC
  - Exelus claims the cost of H_2SO_4 conversion is double that for SAC, so \$128M
- \$100M, AQMD Norton Study of MHF alternatives

This is consistent with other mandates to protect public health--

Cost of Electrostatic Precipitator (ESP), \$300M in '08:	*\$330M*
Cost to repair ESP after 2015 explosion:	*\$161M*
Mobil's cost to add mitigation systems, develop MHF, and convert the HF unit to MHF: ~\$160M during the late 1980's early 1990's	*\$275M*

Sally Hayati, TRAA 40

Torrance Refining Company

FACT: No alternatives are commercially viable for Torrance, including Sulfuric Acid

- **Solid Acid Catalyst (SAC)**
  - Norton Engineering Study: Too early to be considered commercially viable technology
  - CB&I has one small 2,700 BPD unit in a chemical plant in China
    - Issues with catalyst regeneration cause periodic, unplanned shut downs
  - **NO** commercial plant in the United States
  - April 01, 2017 SCAQMD testimony about UK refinery conversion to SAC was false
    - Checked with numerous sources including the co-owner and a Union Leader of the Grangemouth Refinery - confirmed there never was a unit conversion
    - CB&I stated at AQMD August 02, 2017 Proposed Rule 1410 working meeting that the China Plant is the only commercialized Solid Acid Catalyst Alkylation Unit in the world

- **Liquid Ionic Catalyst: nascent technology is only in initial test phase**
  - Only one ~200 gallon per day demonstration unit running today
  - Norton Engineering Study: Too early to be considered commercially viable technology
  - Chevron plans to install small ~5,000 BPD unit in Salt Lake City
  - August 02, 2017 - AQMD Proposed Rule 1410 Working Group meeting: Chevron confirmed that their technology will not be commercially proven until the Salt Lake City unit is built and operated for a significant multi-year time period
  - UOP in its letter stated that a prudent refinery would wait 4 to 6 years to prove a new technology

References

- *DuPont Design Basis for a new plant in Torrance*
- *Norton Engineering Study and presentation at American Fuel & Petrochemical Manufacturers meeting February 2016*
- *Honeywell UOP Letter to SCAQMD, September 2017*

MYTH - TRAA Slide 33: “Alternatives Exist” – per SCAQMD’s Norton Engineering Study

TRAA “Case Against MHF” Jan 4, 2017 – Slide 33

Alternatives Exist

-SCAQMD Study of MHF Alternatives agreed with TRAA’s recommendations-

- Sulfuric Acid (H_2SO_4)
  - 80% (all but 2) refinery alkylation units in CA use this catalyst
  - A toxic liquid—boiling point 640°F. No dense ground hugging acid cloud.
- Solid Acid Catalyst (SAC)
  - Newer, safe and more environmentally benign
  - Pilot plant has been built in the US
  - Commercial plant in China has successfully operated for one year producing excellent quality alkylate

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- Mobil’s cost to add mitigation systems, develop MHF, convert the HF unit to MHF:

~$160M during the late 1980’s early 1990’s $275M

Torrance Refining Company

FACT: We advised SCAQMD that there are multiple inaccuracies in the Norton Engineering Study

- **Torrance Refinery critiqued the Norton Engineering Study**
  - Significantly understates capital cost estimates and disregards operating cost differentials
  - Norton never validated their assumptions with the Torrance Refinery
  - Burns and McDonnell cost estimate was provided to AQMD presents a realistic cost estimate and addresses the deficiencies of the Norton Report
    - Assumptions do not hold up - resulting in a much higher cost estimate
  - No refinery has ever switched from MHF alkylation to a different alkylation technology
    - Equipment is fundamentally different
    - New grassroots process unit would be required
    - April 1, 2017 SCAQMD testimony on conversions was inaccurate and unfounded

- **AQMD August 23, 2017 Proposed Rule 1410 working meeting: DuPont confirmed the Norton Study estimates were low and not representative of a new unit in Southern California. DuPont provided the estimate to Norton, which was based on Gulf Coast costs and did not include scale-up or outside the battery limits scope**

References

- *TORC Letter Submitted to AQMD (Dec. 8, 2016) Re: Norton Engineering Alkylation Study, related to the use of Hydrofluoric Acid in Refinery Alkylation Units*
- *Burns and McDonnell Report Brief – Alkylation Study and Estimate July 2017*

MYTH - TRAA Slides 33 & 37: “Alternatives Exist - SCAQMD Study of MHF Alternatives agreed with TRAA’s recommendations-”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 33

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Sally Hayati, TRAA 33

TRAA “Case Against MHF” Jan 4, 2017 – Slide 37

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Sally Hayati, TRAA 37

Torrance Refining Company

FACT: PBF continues evaluating alternative technologies

- **We have met with experts from Honeywell / UOP, Stratco, DuPont and Burns & McDonnell, as well as independent alkylation experts to explore alternatives**
  - Sulfuric Acid Alkylation is the only commercially viable alternative
    - Presents unique challenges
  - Solid Catalyst and Liquid Ionic Alkylation have been in development for decades
    - There are no commercially viable units running in the U.S.

- **Through the Court-ordered Consent Decree process, MHF Alkylation was determined to be "…as safe as or safer than Sulfuric Acid technology"**
  - Converting to or building a grassroots Sulfuric Acid Alkylation Unit would be inconsistent with the Consent Decree, increase risk to the public, not any safer than MHF, increase emissions, and does **NOT** make sense

- **Before transitioning from MHF Alkylation to a catalyst other than Sulfuric Acid at the Torrance Refinery, the new technology must be proven**
  - Inherently safer than MHF Alkylation
  - Commercially viable in scope and scale to our existing unit

- **We are confident the safety systems on the MHF Alkylation Unit protect our employees and the community while reliably producing CARB gasoline**

Torrance Refining Company

MYTH - TRAA Slides 33 & 37: Alternatives Exist – SCAQMD Study of MHF Alternatives agreed with TRAA's recommendations"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 33

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Sally Hayati, TRAA 37

****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: SCAQMD's Norton Engineering Study does NOT agree with TRAA's recommendation

- **Norton Engineering's Study states that Sulfuric Acid Alkylation is the only currently available alternative to MHF Alkylation**
- **Sulfuric Acid Alkylation introduces a different set of risks and impacts**
  - Risks and impacts include direct and indirect increases in greenhouse gases and criteria pollutants, and community risk
- **Norton Engineering's Study also states that Solid Acid Catalyst (SAC) is in the early stages of development and needs time to be proven safe and reliable**
  - Rules out SAC as a commercially viable alternative to MHF Alkylation
  - Silent on whether a pilot plant has been built in the U.S., as TRAA states
  - Various companies have been developing SAC technology for decades and the process and catalyst are not commercially viable
  - CB&I stated at AQMD August 02, 2017 Proposed Rule 1410 working meeting that the China Plant is the only commercialized Solid Acid Catalyst Alkylation Unit in the world
    - Operating details, product quality, run length and turnaround interval, catalyst regeneration, and feedstocks are currently unknown
    - Technology is not commercially viable

Reference

- *Norton Engineering Study*

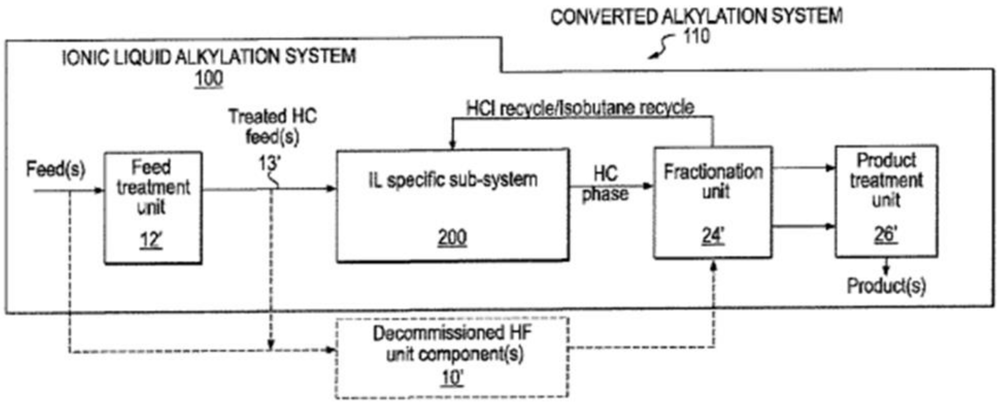
Torrance Refining Company

MYTH - TRAA Slide 34: "TRC's Interest in ILA [Ionic Liquid Alkylation] is a Delay Tactic"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 34

TRC's Interest in ILA is a Delay Tactic

- Norton investigated ILA. The Honeywell ILA announcement added no new info.
  - It concluded (as did TRAA) that ILA is not available to refineries other than Chevron,
  - There's no guaranteed date by which ILA will be available, nor accurate cost estimates, etc.
- ILA provides no significant technical, cost, or societal benefit over SAC or H2SO4
  - ILA needs a substantially longer transition period: there's no justification for that
  - Chevron/Honeywell state the conversion cost is comparable to H2SO4
- PBF won't voluntarily convert after Chevron switch and ILA commercial availability
  - PBF would be free to claim (still) it can't afford conversion and would have to shut down
- We need a max 3-yr deadline for MHF elimination, by 2020. No time for R&D.
  - No more blind trust in industry R&D projects
  - Choice of an alternative should be left to the refinery



Sally Hayati, TRAA

34

Torrance Refining Company

FACT: PBF continues to evaluate alternative technologies

- **PBF has met with Honeywell / UOP to discuss ILA technology**
  - Researchers from various companies have been working on ILA technology for decades, yet ILA is still not commercially viable

- **PBF will continue to monitor ILA development**
  - Chevron announced they will build an ILA unit ~15% the size of the Torrance unit

- **Chevron at AQMD August 02, 2017 Proposed Rule 1410 Working Group meeting stated that the ILA technology will not be commercially proven until the Salt Lake City unit is built and operated for some indeterminate time period**
  - Even after built and operated for some indeterminate time, the technology may not be commercially proven
  - Chevron stated that its Salt Lake City Refinery HF Alkylation Unit has never impacted its community

- **If ILA technology becomes commercially viable, PBF will evaluate, but replacement alkylation unit justification will likely not exist based on safe MHF alkylation operations and cost prohibitive nature of a wholesale unit replacement**
  - Must be inherently safer than MHF Alkylation
  - Must be comparable in scope and scale to the Torrance Refinery's existing unit
  - Must run for two, four-year turnaround cycles to be proven reliable

References

- *UOP/ Chevron Data for Salt Lake City refinery*
- *Norton Engineering Study*

MYTH - TRAA Slide 34: ILA, SAC and Sulfuric Acid have comparable societal benefit

TRAA "Case Against MHF" Jan 4, 2017 – Slide 34

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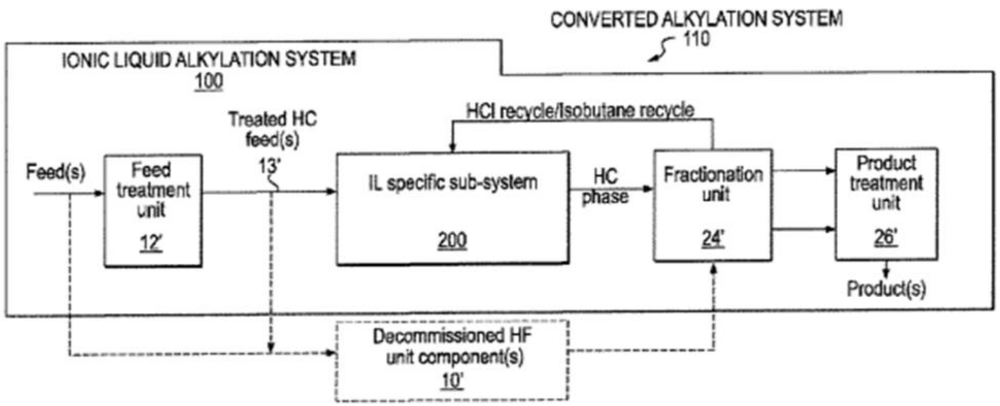

Sally Hayati, TRAA

34

**Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed*

Torrance Refining Company

FACT: A QRA has not been performed on ILA or SAC, so their societal risk cannot / has not been determined

- **Despite decades of development, ILA and SAC technologies are not yet commercially viable**
  - QRAs comparing ILA and SAC to Sulfuric Acid or MHF Alkylation cannot be performed until they are commercially proven
- **Sulfuric Acid Alkylation is one of two commercially-viable alkylation technologies**
  - In the Torrance Consent Decree, MHF "(including mitigation) presents no greater risk than Sulfuric Acid Alkylation plant producing a comparable amount of alkylate"
  - Converting to or building a grassroots Sulfuric Acid Alkylation Unit would be inconsistent with the Consent Decree, increase risk to the public, increase emissions, and does **NOT** make sense
- **Torrance Alkylation Unit is ~30MBD and there are NO commercially viable ILA or SAC plants in the US at or anywhere near this capacity**
  - There are two ILA and SAC demonstration units in operation
    - ILA - Salt Lake City: ~420 gallons per day (ten barrels)
    - SAC - China: 2,500 barrels per day chemical plant reportedly has been unreliable
    - Chevron and CB&I stated at the August 02, 2017 AQMD Proposed Rule 1410 working meeting that these are the only two commercial units and that both technologies are not commercially viable

References

- *UOP/ Chevron Data for Salt Lake City refinery*
- *Norton Engineering Study*

Torrance Refining Company

Chapter 15: Converting the Alkylation Unit Is Implausible

Torrance Refining Company

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MYTH - TRAA Slides 37 & 40: "Studies have been done on HF conversion; R&D [Research & Development] not needed."

TRAA "Case Against MHF" Jan 4, 2017 – Slide 37

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Sally Hayati, TRAA 37

TRAA "Case Against MHF" Jan 4, 2017 – Slide 40

The Cost of Catalyst Conversion

-Estimates vary-

To Sulfuric Acid

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  - The cost to build a unit twice this size would not be twice the price. "The cost of the conversion from HF alkylation to H2SO4 alkylation is a fraction of that of a grassroots unit as it uses most of the existing equipment." Dupont.

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FACT: There has NEVER been an M/HF Alkylation unit converted to another alkylation technology

- **A Stratco Alkysafe Unit has <u>NEVER</u> been built or commercially proven**
  - Additionally, DuPont's current equivalent technology ConvEx is not commercially available
    - Merely a concept - only completed paper case studies
    - No pilot or field testing - no conversion has ever been undertaken

- **There has <u>NEVER</u> been an MHF/HF unit converted to Solid Acid Catalyst**
  - Confirmed by CB&I at the August 2, 2017 AQMD Proposed Rule 1410 Working Group meeting
    - There is only one 2,500 BPD grassroots SAC plant in China
    - Would have to vet design to validate re-use of equipment
    - Impossible to validate cost because conversion has **<u>NEVER</u>** been done

- **Transitioning from MHF Alkylation to a catalyst other than Sulfuric Acid at the Torrance Refinery, the new technology has to be proven**
  - Must be inherently safer than MHF Alkylation
  - Commercially viable in scope and scale to our existing unit

<u>References</u>

- *DuPont Design Basis for Torrance*
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- *Burns and McDonnell Report Brief – Alkylation Study and Estimate, July 2017*
- *HF Alkylation Consultants White Paper*

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TRAA "Case Against MHF" Jan 4, 2017 – Slide 37

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Torrance Refining Company

FACT: Sulfuric Acid Alkylation <u>DOES NOT</u> eliminate toxic airborne risk - the risk increases

- **With a Sulfuric Acid Alkylation Unit, released sulfuric acid mixed with hydrocarbons can become and remain airborne**
  - Quest Sulfuric Acid experiments convincingly demonstrate this phenomenon
- **Motiva Delaware City H_2SO_4 release cited by TRAA occurred in 2001, not 2011**
  - Caused one onsite fatality, eight injuries, and offsite fish kill
- **Criteria pollutant emissions - SO_2 & SO_3 - are produced from combusting spent Sulfuric Acid in an incinerator during the regeneration process**
  - MHF Alkylation does **<u>NOT</u>** produce SO2 or SO3
- **Sulfuric Acid Alkylation consumes ~2x utilities as MHF Alkylation**
  - Results in increased GHG emissions and larger carbon footprint
  - Each new piece of equipment is a potential source of VOC fugitive emissions
- **Spent Sulfuric Acid is highly corrosive, reactive, flammable**
  - Produces a carcinogenic mist that is more toxic than HF mist per the International Agency on Research for Cancer
  - Spent Sulfuric Acid is listed in the same hazardous material category as M/HF
  - Concentrated fresh and spent Sulfuric Acid are highly dangerous and produce insidious burns to human flesh

<u>Reference</u>

- *CSB Investigation Report (October 2002), Motiva Delaware City Refinery Spent Sulfuric Acid storage tank explosion and fire on July 17, 2001*

MYTH - TRAA Slide 38: "The refinery should temporarily operate without alkylation if the transition takes > 3 years"

TRAA "Case Against MHF" January 4, 2017 - Slide 38

The Transition Period Should be Minimized

- The Consent Decree mandated HF elimination by 1997. It's past time-

- Consent Decree gave 3 years to construct a MHF or sulfuric acid alky unit: 1994-97. Mobil stated in Feb. 1995 it needed no more than two years to switch to MHF.
- In Jan. 2016 Valero announced plans to build a new 13,000 b/d alkylation unit at its Houston refinery with startup in 2018. That's 2 years allocated, including permitting.
- "To construct a sulfuric acid alkylation unit within the existing Refinery… the existing [HF] unit would have to be shutdown and demolished. This and construction of a new alkylation would require approximately 1 year." Valero, Wilmington, 2004
- The refinery should temporarily operate without alkylation if the transition takes > 3 years
  - Alkylation feeds could be transported to alkylation units elsewhere or (possibly) sold for other purposes.
  - Transportation needs for (prev) alky inputs should be similar to & replace current needs for alky output
  - ExxonMobil accepted and stored crude oil shipments for > 1 year during the shut down. It coped.
- Components of the H_2SO_4 alky unit might be (like the ESP)
  - prefabricated at a safer location inside the refinery, then
  - lifted and transported to the final site for installation

"The module approach [to ESP construction] allowed the project to install piling, foundations and structural steel in parallel with ESP assembly, shortening the construction span significantly."

ESP being moved in 2008 to its final location

Sally Hayati, TRAA

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***Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed**

Torrance
Refining Company

FACT: Torrance Refinery becomes uncompetitive if the Alkylation Unit outage lasts more than 30 days

- **ExxonMobil estimated daily gross revenue losses of ~$1 million to $1.5 million due to the closure of the FCC and Alkylation Unit starting in February 2015**
  - When the MHF Alkylation Unit is down, FCC throughput must be reduced to minimum
  - FCC will be limited to one month of operation due to railcar logistics
- **MHF unit makes alkylate for producing cleaner-burning CARB gasoline**
  - Alkylate availability is limited due to high global demand and transport costs
- **The Torrance MHF Alkylation Unit produces a critical blending component for making cleaner-burning CARB gasoline for Southern California and the State of California**
  - Alkylate is required to meet stringent state-mandated gasoline specifications
  - Torrance Refinery supplies ~20% of daily regional demand and ~10% statewide
- **Refinery projects take many years to complete**
  - From permitting design to construction and then startup, each stage is critical to long-term, safe, reliable operations
  - Permitting process is uncertain
  - If steps are skipped or rushed, then mistakes can happen
- **TRAA have no knowledge of refinery / Alkylation - never designed, built, or run a refinery**
  - Unfamiliar with operating, design, procurement, or construction

Reference

- *Seeking Alpha: "Exxon Mobil: About The Torrance Refinery," April 4, 2016*

Torrance Refining Company

MYTH - TRAA Slide 38: “Consent Decree gave 3 years to construct a MHF or sulfuric acid alky unit”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 38

The Transition Period Should be Minimized

- The Consent Decree mandated HF elimination by 1997. It’s past time-

- Consent Decree gave 3 years to construct a MHF or sulfuric acid alky unit: 1994-97. Mobil stated in Feb. 1995 it needed no more than two years to switch to MHF.
- In Jan. 2016 Valero announced plans to build a new 13,000 b/d alkylation unit at its Houston refinery with startup in 2018. That’s 2 years allocated, including permitting.
- “To construct a sulfuric acid alkylation unit within the existing Refinery… the existing [HF] unit would have to be shutdown and demolished. This and construction of a new alkylation would require approximately 1 year.” Valero, Wilmington, 2004
- The refinery should temporarily operate without alkylation if the transition takes > 3 years
  - Alkylation feeds could be transported to alkylation units elsewhere or (possibly) sold for other purposes.
  - Transportation needs for (prev) alky inputs should be similar to & replace current needs for alky output
  - ExxonMobil accepted and stored crude oil shipments for > 1 year during the shut down. It coped.

- Components of the H_2SO_4 alky unit might be (like the ESP)
  - prefabricated at a safer location inside the refinery, then
  - lifted and transported to the final site for installation

“The module approach [to ESP construction] allowed the project to install piling, foundations and structural steel in parallel with ESP assembly, shortening the construction span significantly.”

ESP being moved in 2008 to its final location

Sally Hayati, TRAA

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**Note: Purple box added to TRAA’s original image/text to highlight specific points referenced/discussed*

FACT: Consent Decree gave seven years to design, test and construct the Torrance MHF Alkylation Unit

- **Court entered Consent Decree with Mobil and City of Torrance in October 1990**

- **May 1995: After more than two years of study, analysis, and testing, the Court ordered the phase-out of AHF and replacement with MHF**
  - Based on the Safety Advisor's recommendation to the Court

- **1997: After SCAQMD issued required permits, MHF Alkylation Unit started up**
  - Unit only required modifications rather than a complete rebuild

Reference

- *Consent Decree Safety Advisor Report , October 1999*

MYTH - TRAA Slide 39: PBF Energy paid $537.5M for the refinery

TRAA "Case Against MHF" Jan 4, 2017 – Slide 39

THE TORRANCE REFINERY: NOT A THROW AWAY

-THE REFINERY WOULD NOT BE SHUTDOWN SIMPLY TO AVOID THE COST OF CONVERSION-

750 acres: 1 mi x 0.76 mi
High-conversion 155K BPD, delayed-coking refinery,
Nelson Complexity: 14.9
Strategically positioned. Advantaged logistics: flexible raw material sourcing and products to/from CA, NV, AZ.
171-mile crude oil gathering & transportation system delivering San Joaquin Valley crude oil. Crude oil pipelines from ports of LA & Long Beach
Jet fuel pipeline to LAX. ~8.6M barrel crude/product storage capacity.

***PBF**: "The Torrance Refinery acquisition is another significant step in the continued growth of PBF Energy ... So. CA is a very attractive market and we are excited to become a supplier in the region...[W]e are entering at a very attractive purchase price for the Torrance refinery." **TRC**: The refinery [$537.5M price] is a $1B value, the XOM pipelines alone were sold for $350M to another PBF subsidiary. A new refinery would cost $2-4B."*

Sally Hayati, TRAA 39

****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: PBF Energy paid a total of $537.5MM for the refinery *and* logistics assets - the refinery alone was valued at $187.5MM

- **The cost of the refinery must be taken into consideration when evaluating the replacement of the MHF Alkylation Unit or any other major investment**
  - Estimate for a new Sulfuric Acid Alkylation Unit is ~$600MM, with an additional ~$300MM for a Sulfuric Acid Regeneration Unit and Incinerator
    - Combined project cost estimate is ~$900MM

References

- *Public Record on refinery price and PBF value*
- *Burns and McDonnell Report Brief – Alkylation Study and Estimate, July 2017*

Chapter 16: A Phase-Out or Ban is Illogical

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MYTH - TRAA Slide 41: "PBF Energy can deal with a MHF Ban"

TRAA "Case Against MHF" Jan 4, 2017 – Slide 41

PBF Energy Can Deal With a MHF Ban

2015: PBF Energy purchased a 189,000 b/d refinery in Chalmette, Louisiana, from ExxonMobil and Venezuelan national oil firm PdV. 189.

"PBF closes in on swift expansion," Argus Media, <https://www.argusmedia.com/pages/NewsBody.aspx?id=1127621&menu=yes>

- This refinery has an idled hydrocracker, catalytic reformer and coker.
- PBF told the press they might operate the refinery without those units but will bring these units up if that proves to be "economic."
- PBF anticipates the need for immediate changes in the types of crude oil the refinery processes, such as using medium and heavy sours.
- PBF anticipates the need for immediate changes in products sold by the refinery.
- Yet PBF states that a ban on MHF at Torrance refinery would require a shutdown
  - Would need to raise capital for improvements (~$300M), possibly tolerate one idled unit for 3-4 years, and the need to sell a different set of products while the alkylation unit is idled. Possible need to use different feedstock upon the switch from HF to sulfuric acid.
  - These are essentially the same challenges Chalmette poses.
- PBF is adapting with equanimity to 3 idle units and the need for changes in feedstock and products at the Chalmette refinery.

So why would PBF abandon their entire investment in the high capacity, high complexity Torrance refinery rather than tolerate a single idled unit (alkylation) while converting to a new catalyst?

Sally Hayati, TRAA 41

Torrance Refining Company

FACT: Torrance Refinery MHF Alkylation Unit must be kept running to make CARB gasoline required by California

- **MHF Alkylation Unit produces a critical blending component for making clean-burning CARB gasoline for Southern California and the State of California**
  - Alkylate is required to meet stringent state-mandated gasoline specifications
  - Torrance Refinery supplies ~20% of daily regional demand and ~10% statewide

- **When the Torrance Refinery MHF Alkylation Unit was down following the ExxonMobil 2015 ESP incident, most of the refinery's gasoline was sent out of state**
  - Unable to meet CARB specs - refinery not viable with MHF Alkylation Unit down
  - California motorists reportedly paid a premium of $1/gallon when the Torrance Refinery MHF Alkylation Unit was down following the February18, 2015 ESP incident

- **California Energy Commission statement from AQMD Proposed Rule 1410 Working Group Meeting September 2, 2017**
  - "Supply impacts of two refineries being close down expected to be greater in magnitude, of longer duration, and higher in costs to motorists and truckers than those resulting from the temporary loss of gasoline production capability at Torrance Refinery following the ESP explosion on 2/18/15"

Reference

- *California Energy Commission Presentation, September 20, 2017*

MYTH - TRAA Slide 42: “The Refinery Can Survive a Temporary Suspension of Alkylate Production”

TRAA “Case Against MHF” Jan 4, 2017 – Slide 42

The Refinery Can Survive a Temporary Suspension of Alkylate Production

- A firm deadline must be mandated for MHF removal.
  - Gasoline still be produced at refinery even if the alky unit is offline temporarily

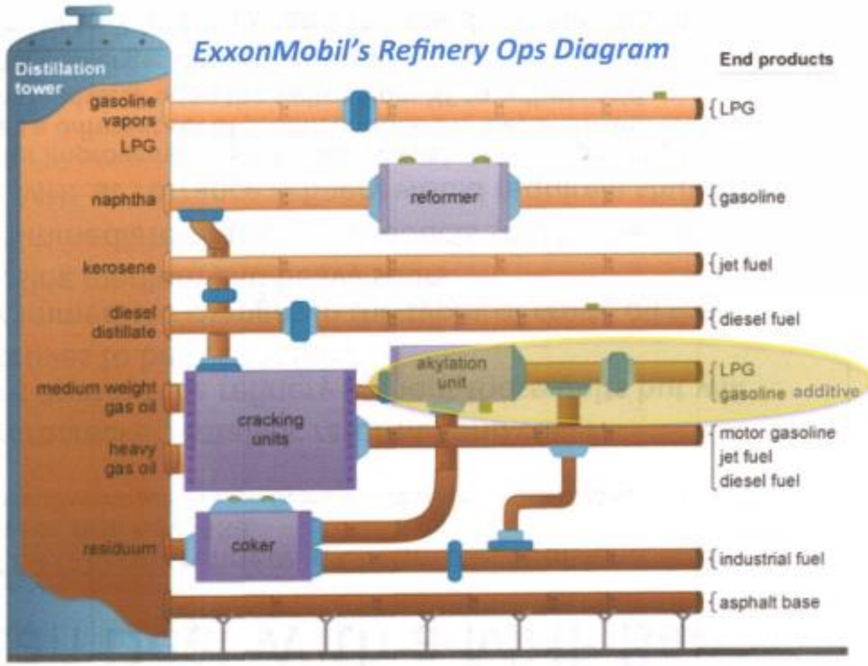
Input feeds to alky unit would require alternate treatment, shipping, sale, or storage

- This is not unimaginable: Marathon plans stand-alone alkylation units similar to MTBE units (earlier tech)

The industry can innovate when it’s in its interest to do so

- MarkWest plans to create stand-alone alkylation “hub” in the Ohio natural gas fields, > 60 mi. from nearest refinery, to use butane

So innovation to protect public health & safety is also possible



Sally Hayati, TRAA

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Torrance Refining Company

FACT: Idling the MHF Alkylation Unit at the Torrance Refinery would cause the site to be immediately unprofitable

- **MHF Alkylation enables Torrance to meet California's strict gasoline requirements**
  - Refinery must comply with CARB gasoline requirements
  - If unit is idled, the Refinery would have to purchase expensive alkylate that would normally be produced by the unit

- **Torrance Refinery lacks rail capacity to sell its complete Alkylation feed volume from the FCC, which would force the refinery to reduce production**

- **Long-term viability is threatened whether FCC is at reduced rates or shut down**
  - Evidenced by 2015/2016 refinery losses related to shutdown of the Torrance Refinery's FCC and MHF Alkylation Unit following the February 18, 2015 ESP incident

- **TRAA slide cites one-time deals, describes unattainable petroleum market conditions**
  - Slide references a PFD that does **NOT** reflect current Torrance refinery operations
  - Slide illustrates TRAA's lack of expertise and experience in commercial petroleum transactions, logistics movements, and refinery operations

References

- *Site experience post ExxonMobil February 18, 2015 ESP Incident*
- *Market economics*

Torrance
Refining Company

MYTH - TRAA Slide 43: California market will not be impacted by a reduction in alkylate production

TRAA "Case Against MHF" Jan 4, 2017 – Slide 43

CA Can Survive a Temporary Reduction in Alkylate Production

- Torrance refinery can produce gasoline even if the alkylation unit is down
  - Alkylate used as blendstock to produce 84 and 88.5 octane LA CARBOB grades.
- Alkylate for CA can be and has been purchased from out of state
  - Routine during strikes and when refineries blow themselves up
    - Golden Eagle in Martinez "completely shut" due to strike: 12,000 b/d alkylate production
    - ExxonMobil 2/18/2016 explosion: 24,200 b/d alkylate production
  - Why not, to promote public safety, import alkylate while building new alky unit?
  - 760,350-1,183,00 barrels of gasoline and alkylate were delivered in March 2015 to the US West Coast, including alkylate exports from Japan.
  - Maersk Miyajima carries 331,000 barrels of alkylate.
- Even CA gasoline itself is routinely produced outside of CA
  - Domestic sources: Washington State, US Gulf Coast.
  - Foreign sources: Canada, Finland, Germany, US Virgin Islands, Middle East, Asia
- Statistics show cost fluctuation is not direct function of CA production levels

Sally Hayati, TRAA

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****Note: Purple boxes added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: California markets rely on alkylate production to comply with CARB regulations for cleaner-burning gasoline

- **Banning MHF Alkylation would drive demand for and cost of alkylate higher**
  - Alkylate would have to be imported into California
    - Foreign imports would be dependent on global octane demand and pricing
  - Banning effect: would likely increase cost of gasoline to consumers as evidenced by the reported $1/gallon spike following the February 18, 2015 ESP incident

- **According to California Energy Commission**
  - Permanent production loss in gasoline blending components would be 60.4% greater than the temporary loss associated with the February 18, 2015 ESP incident
  - Incremental impacts on gasoline costs for consumers and businesses could be as bad or worse than those experienced as a result of the ESP incident
  - Gasoline prices averaged 26 cents per gallon greater than normal for 17 months
  - Equates to increased incremental costs of $5.6 billion for motorists and businesses
  - Closure of two refineries would also increase prices for diesel and jet fuel

References

- *CEC September 20, 2017 Presentation "Potential Transportation Fuel Supply and Price Impacts of HF Ban, Proposed Rule 1410 Working Group Meeting #6", Slide 27 – "HF Ban – Fuel Price Implications"*

MYTH - TRAA Slide 41: Gulf Coast market economics are identical to California's market

TRAA "Case Against MHF" January 4, 2017 - Slide 41

PBF Energy Can Deal With a MHF Ban

2015: PBF Energy purchased a 189,000 b/d refinery in Chalmette, Louisiana, from ExxonMobil and Venezuelan national oil firm PdV. 189.

"PBF closes in on swift expansion," Argus Media, <https://www.argusmedia.com/pages/NewsBody.aspx?id=1127621&menu=yes>

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- Yet PBF states that a ban on MHF at Torrance refinery would require a shutdown
  - Would need to raise capital for improvements (~$300M), possibly tolerate one idled unit for 3-4 years, and the need to sell a different set of products while the alkylation unit is idled. Possible need to use different feedstock upon the switch from HF to sulfuric acid.
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Sally Hayati, TRAA

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****Note: Purple box added to TRAA's original image/text to highlight specific points referenced/discussed***

Torrance Refining Company

FACT: Market economics on the Gulf Coast - PADD 3 - and West Coast - PADD 5 - are distinct and unassociated

- **Chalmette and Torrance operate in distinct, separate markets with different product specifications and demands**
  - Make different products with specifications that vary from each other
  - 57 operating refineries in PADD 3 (Gulf Coast); 30 operating refineries in PADD 5 (West Coast)

- **Potential crude changes at Chalmette have nothing in common and have very different consequences than alkylation feed changes at Torrance**
  - Absolutely no connection between idle operating units at Chalmette and Torrance not operating an Alky Unit - Chalmette's HF Alky Unit was never idled
  - Idling the MHF Alkylation Unit at the Torrance Refinery would cause the site to be unprofitable due to CARB's strict gasoline blending requirements
  - This example shows TRAA's lack of expertise and experience regarding the refining industry, operations, and markets

<u>**References**</u>

- *Site experience post ExxonMobil February 18, 2015 ESP Incident*
- *Market economics*
- *US Energy Information Administration - Number and Capacity of Petroleum Refineries (as of Jan 2016)*

Chapter 17: Summary

Summary: Torrance Refinery's use of MHF is safe

- **MHF is the safest, most recent, commercially proven advance in Alkylation technology available to Torrance Refinery**
  - Rigorous testing and modeling were conducted by Mobil and Phillips Petroleum
  - Reviews & approvals: Safety Advisor, Superior Court, City of Torrance, SCAQMD
  - Torrance MHF Unit product yield and quality are comparable to HF alkylation

- **There has never been an offsite M/HF release from the Torrance Alkylation Unit**
  - 1966: HF Alkylation Unit commissioned
  - 1997: Switched to MHF
  - 51 years of operation without an offsite release
    - Includes 6.5+ magnitude Sylmar (1971) and Northridge (1994) earthquakes

- **TRAA activists oppose MHF Alkylation**
  - Use illegitimate examples to attack MHF efficacy
  - None of their self-styled "Science Advisory Panel" members have relevant education or experience in refining or alkylation
  - Use misinformation and disinformation to generate fear and outrage among a small group of residents

Note: *Prior slides provided supporting statements and references*

Summary: Alternative Technologies

- **TRAA endorsed Sulfuric Acid Alkylation based on a FLAWED assumption of significantly lower risk than MHF**
  - Sulfuric Acid Alkylation is also hazardous and offers no advantage over MHF
  - U.S.: 50 M/HF units and 39 sulfuric acid plants, which require more processing

- **Alternative alkylation technologies are evolving, yet unproven at full scale**
  - There are **NO** commercially proven, new alternative alkylation solutions available at this time

- **PBF continues evaluating emerging alkylation technologies**

Note: *Prior slides provided supporting statements and references*

Torrance Refining Company

Summary: MHF in AQMD's Own Words

The following quotes are from public AQMD documents - the information presented is applicable to MHF and barrier use at the Torrance Refinery

- **News release: "Highly Toxic Chemical to be Phased Out at Valero Refinery" 2/7/03:** "Once this refinery stops using concentrated hydrogen fluoride, we will have virtually eliminated the potential for a catastrophic accidental release of this compound in our region." Barry Wallerstein, former AQMD Executive Officer
- **Wilmington Refinery Alkylation Improvement Project, Final EIR Ch. 2, p. 2-7,**

  "The modified HF catalyst reduces acid vapor pressure sufficiently to suppress the usual flash atomization process of hydrofluoric acid, causing most of the acid to fall to the ground as an easily controlled liquid and reduces the potential for off-site consequences of an accidental HF release."
- **February 7, 2003, Governing Board Letter, Agenda No. 25**

  "To further minimize public exposure to potential HF releases, the refinery is proposing to use modified HF in the alkylation process and upgrade its mitigation system to include deflector barriers for HF pumps and flanges. This proposed change meets the intent of the former Rule 1410 and will significantly reduce the potential for public exposure to this hazardous chemical in the event of an emergency release."

ADDENDUM:
GLOSSARY OF TERMS

Glossary of Terms

- **Acid strength / acid concentration:** The weight percent of acid in the alkylation unit main acid stream
- **Additive:** A heavy liquid component added to anhydrous hydrofluoric acid (AHF), which reduces aerosol properties of AHF through hydrogen bonding; additive is the “M” in “MHF” or “modified” HF. Additive is one of the five components of the main acid stream in the MHF alkylation process
- **Acid detecting paint:** Yellow paint that is painted on flanges and other surfaces in the alky unit, which turns red in the presence of hydrofluoric acid (HF)
- **Aerosol / aerosoling:** Dispersing a substance into fine particles or a “mist” suspended in the air; examples of aerosoling are fog or hair spray
- **AES / Acid Evacuation System / Rapid Acid Dump (RAD) System:** A process in which the acid contained in an alkylation unit is rapidly moved to a safe location; typical de-inventory is 5-7 minutes
- **AHF**: Anhydrous hydrogen fluoride / hydrofluoric acid. Anhydrous HF contains no water or other components besides HF (>99% pure HF)
- **Alkylate:** The main product in the alkylation process; alkylate is a high octane, low sulfur component required to blend cleaner-burning CARB gasoline
- **Alkylation:** A refining process in which light olefins (propylene, butylene) are upgraded to a high octane, low sulfur gasoline blendstock. Gasoline regulations in the United States favor alkylate blendstock due to its lower emissions.
- **AQMD** / **SCAQMD**: South Coast Air Quality Management District - the air pollution control agency for Orange County, Los Angeles, Riverside, and San Bernardino counties
- **API:** American Petroleum Institute - The only national trade association that represents all aspects of America’s oil and natural gas industry. API’s mission is to promote safety across the industry globally and to influence public policy in support of a strong, viable U.S. oil and natural gas industry.

Glossary of Terms

- **API 751 /API RP 751:** American Petroleum Institute Recommended Practices for safe operations of HF Alkylation units. RP 751 is an industry document that communicates proven industry practices to support the safe operation of an HF acid alkylation unit
- **ARF: Airborne Reduction Factor - t**he percent reduction in airborne HF as compared to an unmitigated AHF release. Larger ARF = less HF released to atmosphere. ARF is calculated using acid strength, water, additive, and reactor temperature. The ARF calculation was developed from extensive lab testing at varying percentages of each component. The refinery reports ARF values monthly to TFD.
- **ASO: Acid soluble oil -** a polymer and byproduct of the alkylation process and one of the five components of the main acid stream in the MHF alkylation process
- **Barrel / bbl:** A barrel of oil; one barrel of oil is equivalent to 42 US gallons
- **Barrier:** An enclosure which intercepts / captures a released jet of MHF which enables it to rainout instead of aerosoling; there are multiple types of barriers at Torrance including flange shrouds, pump enclosures, or barrier or “belly” pans under acid settlers
- **Belly Pan:** A barrier or enclosure surrounding the bottom area of the settler, which contains a large portion of the unit’s MHF. The belly pan captures MHF in the event of a release.
- **Blast wall:** A physical wall surrounding the acid storage and rapid acid dump vessel in the alkylation unit in order to protect both vessels from a major process upset
- **BOL: Bill of Lading** - The certificate a truck must present to the refinery in order to enter and make a delivery; a BOL shows the composition and quantity in the truck from the manufacturer
- **BPD:** Barrels per day
- **Cal/OSHA: California Division of Occupational Safety and Health (DOSH) -** a government agency which protects and improves the health and safety of employees working in California

Glossary of Terms

- **Catalyst:** A chemical which enhances or enables a reaction to occur without being destroyed or consumed in the reaction; HF is the catalyst in the HF alkylation process
- **CCPS: Center for Chemical Process Safety** - an organization within the American Institute of Chemical Engineers (AIChE) that identifies and addresses process safety needs within the chemical, pharmaceutical, and petroleum industries
- **CD / Consent Decree / City of Torrance Consent Decree:** Ordered by the Superior Court for the County of Los Angeles and developed in the 1990s based on recommendations by the City of Torrance, Mobil, and a court-appointed Safety Advisor (SA) to phase out anhydrous HF by 1997 and ensure the refinery operates in a safe manner. There are multiple post-decree obligatory items including reporting and communication protocols with TFD that were approved by the Superior Court
- **CSB: Chemical Safety Board** - an independent U.S. federal agency charged with investigating industrial chemical accidents. Headquartered in Washington, D.C., the agency's board members are appointed by the president and confirmed by the United States Senate. The CSB conducts root cause investigations of chemical accidents at fixed industrial facilities.
- **Desert Test / Nevada Desert test :** Testing conducted in 1986 to determine release properties of anhydrous HF
- **EPA: Environmental Protection Agency** - an agency of the Federal government of the United States that has the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.
- **EPA Worst Case Scenario:** A component of the EPA's Risk Management Program or RMP which aims to understand potential offsite impacts in the event of a release of a toxic substance
- **ERPG-2: Emergency Response Planning Guidelines Tier 2** - part of the EPA's RMP; the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- **ESP: Electrostatic Precipitator** - a pollution control device on the back-end of the FCC unit which collects FCC catalyst particles, preventing them from being released to the atmosphere
- **ExxonMobil:** The owner and operator of the Torrance Refinery from 1999-2016

Glossary of Terms

- **FCC/FCCU: Fluidized Catalytic Cracking Unit** - makes feedstock for the alkylation unit and other gasoline components used to blend CARB gasoline
- **First Principles:** Scientific theoretical work is said to be from first principles if it starts directly at the level of established science and does not make assumptions such as empirical model and fitting parameters.
- **Flange barrier / flange shroud:** One of the MHF barriers at Torrance which fully wrap around pipe flanges and enclose the flange. Shrouds are tested annually for integrity and efficacy with the Torrance Fire Department
- **Flash Atomization:** The act of a substance disintegrating into small droplets when a pressurized liquid is released into the atmosphere. Modified HF eliminates the ability for flash atomization of HF to occur.
- **Flash Vaporization:** A liquid stream partially vaporizing under certain pressure and temperatures. Flash vaporization typically occurs from a large drop in pressure which causes the fluid to rapidly vaporize or “flash”
- **HC / light ASO: Hydrocarbon / light acid soluble oil** - a component of the main acid stream which has a lower boiling point than “normal” ASO
- **HF alkylation:** Alkylation process which uses hydrogen fluoride as the reaction catalyst
- **Honeywell / UOP:** Honeywell manufactures modified HF which is sold to the Torrance Refinery; UOP owns the ReVAP and HF alkylation technologies
- **Hydrogen bonding:** An attraction between a hydrogen atom and another atom or molecule, such as water. Water’s high boiling point can be attributed to its strong hydrogen bonding relative to its low molecular weight.
- **IARC: International Agency for Research on Cancer –** specialized inter-disciplinary cancer agency of the World Health Organization that promotes international collaboration in cancer research so that preventive measures may be adopted
- **Ionic liquid Alkylation/ILA:** A new alkylation technology developed by Chevron licensed to UOP which has only been tested on a small scale. A small scale plant is planned to be developed and implemented by 2020 at Chevron’s Salt Lake City refinery

Glossary of Terms

- **Isobutane:** One of the main feedstocks for the alkylation unit
- **Jet Release:** The act of a substance disintegrating into small droplets when a pressurized liquid is released into the atmosphere.
- **KB:** Thousand barrels
- **Mobil:** The Torrance Refinery's owner and operator until 1999 when Exxon and Mobil merged
- **MHF**: "Modified" hydrogen fluoride / hydrofluoric acid – hydrofluoric acid with an additive depressant to prevent flash atomization
- **MHF Alkylation / ReVAP:** Reduced Volatility Alkylation Process which uses a heavy liquid additive to suppress aerosolization properties of hydrogen fluoride
- **MHF-AUA:** Modified Hydrogen Fluoride Alkylation Unit Acid
- **Naphtha:** A product made from the FCC which is a key blendstock for CARB gasoline
- **Norton Study / Norton Alkylation Technology Study:** A study commissioned by the South Coast Air Quality Management District assessing the different options of alkylation technologies issues in September 2016
- **Olefin / PBB:** Main feedstock for the alkylation unit which is produced from the FCC – (PBB –propylene, butylenes, butanes)
- **Passive mitigation:** A mitigation system which requires no human or mechanical interaction
- **PBF: PBF Energy** - the current owner and operator of the Torrance Refinery since July 2016
- **TORC: Torrance Refining Company, a subsidiary of PBF Energy,** the current owner and operator of the Torrance Refinery since July 2016
- **PSM**: Process safety management

Torrance Refining Company

Glossary of Terms

- **QRA:** Quantitative Risk Assessment - an industry standard methodology that considers a broad range of scenarios, applies probability of likelihood, and highlights most effective risk mitigation options.
- **Rainout:** The act of a substance forming a liquid and dropping or "raining" to the ground. "Rainout percent" refers to the percentage of released liquid HF which remains as a liquid due to rainout.
- **Reactor:** Vessel in which alkylation reaction takes place. Olefin, isobutane, and acid are combined in reactor to make alkylate
- **Regeneration / acid regeneration:** The process in which byproducts / contaminants produced in the alkylation reaction are removed from the acid stream so the acid can be reused
- **RMP** / **EPA RMP: Risk Management Plan -** part of the Clean Air Act, which requires EPA to publish regulations and guidance for chemical accident prevention at facilities which use hazardous substances.
- **SA / Safety Advisor:** A Superior Court-appointed safety advisor responsible for reviewing, investigating, and developing recommendations around modified HF and overall safe operation of the refinery including the MHF unit at the Torrance refinery; recommendations were documented in the Safety Advisor Report and implemented in the Torrance Consent Decree, which bound the Torrance refinery to adhere to these recommendations
- **Settler / acid settler:** A horizontal vessel in the alkylation unit that separates acid from hydrocarbon / alkylate (based on density) after the alkylation reaction has occurred
- **Solid Acid Catalyst (SAC) alkylation:** An alkylation process not yet commercially viable which uses a zeolite catalyst to produce alkylate. One plant (<3 kbd) has been in operation in China since 2015.
- **SRI: Societal Risk Index** - a measure of risk to the general public which accounts for all safety factors affecting the alkylation unit; lower SRI = lower risk. SRI is affected by multiple factors including ARF, number of acid truck deliveries, and the availability of critical safety systems such as barriers, AES, HF detectors, fire monitors / deluge. The refinery stewards and reports SRI quarterly to the Torrance Fire Department

Glossary of Terms

- **Stratco Alkysafe:** The process in which an HF unit is converted to sulfuric acid; process is a patent and has never been implemented in an actual refinery
- **Sulfuric Acid alkylation:** Alkylation process which uses sulfuric acid (H_2SO_4) as the reaction catalyst
- **TFD:** Torrance Fire Department
- **TRAA: Torrance Refinery Action Alliance** - grassroots organization of South Bay residents and business owners against MHF
- **Vapor pressure:** The pressure exerted by a vapor that is in equilibrium with its solid or liquid form - volatility is directly related to vapor pressure. A substance with a high vapor pressure is considered volatile.
- **Water:** One component in the main acid stream which acts as an HF vapor suppressant (via hydrogen bonding), reducing aerosoling of HF. Water concentration is limited to 3 wt% due to corrosion issues
- **Water Cannon:** A water mitigation system which suppresses HF vapors in the event of a release