Texas Progress in Flaring – 6 Years of Emissions Data

2015 through 2020

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ABSTRACT

Following nearly a decade of flare performance inquiry, modeling, and testing in the early 2000's, new United States Environmental Protection Agency (USEPA) flare regulations have been enacted for the petroleum refinery sector in 2012 and 2015. The stated objective of these new regulations was the decrease of emissions such as sulfur dioxide (SO_2) and an improvement of combustion efficiency directed at reductions in volatile organic compounds (VOC). With six years of speciated emissions data now available from the Texas Commission on Environmental Quality (TCEQ) as well as other publicly available sources, an introductory review of the impact of these new regulations can be assessed.

The paper will present an overview of the flare related emissions from the 2,262 flares identified in the Texas dataset. Emphasis will be placed upon a discussion of four key topics:

1. 2015's NSPS Subpart Ja regulation and the management of H_2S and reduction of SO_2 emissions. With the use of frequent compressor-based Flare Gas Recovery Systems, might one expect to see Statewide SO_2 numbers decrease substantially?

2. NOx – with USEPA's adjust and clarification of AP-42 emission factors in both 2015 and again in 2018 (based upon the prior decade of flare testing) would one expect to see flare related emissions increase, decrease, or remain consistent?

3. VOC emissions – the essential aspect of the Refinery MACT Subpart CC rules in 2015 was the anticipated expansion of more instrumentation, minimization studies, more FGRS, all for the purpose of demonstrating improved and consistently better Combustion Efficiency and increased Destruction Removal Efficiency (DRE).

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4. Texas had a pre-existing 2004 regulatory program to target Highly Reactive VOC (HRVOC) emissions from industrial flares surrounding Houston's non-attainment area. HRVOC targeted flares already had flow and calorific value instrumentation at the time of the latest 2012 and 2015 USEPA regulations. The current status of flare related HRVOC emissions will be presented.

Background

The state of Texas does provide a summary of the overall emissions profile for the entire state based on previous year's reported emissions[2].

Pollutant (tpy)	2015	2016	2017	2018	2019	2020
VOC	98,000	90,000	89,000	90,000	91,000	88,000
NO_x	259,000	251,000	250,000	248,000	240,000	217,000
SO_2	335,000	319,000	353,000	282,000	215,000	191,000
CO	251,000	270,000	288,000	246,000	223,000	212,000
PM_{10}	46,000	44,000	46,000	41,000	41,000	38,000
$PM_{2.5}$	33,000	32,000	33,000	30,000	30,000	29,000
Total (*does not include PM2.5 to avoid double counting particulate matter*)	989,000	974,000	1,026,000	909,000	811,000	747,000

Overall, the emissions picture for Texas appears very good, the effects of the COVID pandemic notwithstanding. The record suggests a steady decline of all pollutants in all categories.

The basis for the TCEQ's HRVOC rule started with agency and industry inquiry in 2003. The HRVOC rule was promulgated in Texas and only for certain industrial flares within the Houston non-attainment area in 2004. There was some justification cost; how much do these analyzer cost; flow meters in the Houston area. This is the baseline emission inventory that justified HRVOC as a program. The program was broken down using a special emissions inventory in 2008 and data was presented by the TCEQ's consultant, Environ[3]. Table 3 from the Environ report is reproduced below.

[2] https://www.tceq.texas.gov/airquality/point-source-ei/psei.html

[3] https://www.tceq.texas.gov/assets/public/implementation/air/rules/contracts/2008-hrvoc-cost-analysis-final.pdf

Table 3. HRVOC Special Inventory Summary (Mass)						
Source	Emissions by Industry Sector (tons)					
	Chemical[2]	Olefins	Polymers	Refining	Terminal[2]	Combined[2]
Flares	278.3	376.7	460.0	308.7	45.8	1,469.5
Cooling Towers	35.4	18.1	20.9	88.1	0.1	162.6
Other Vents	97.5	157.1	221.1	125.0	1.7	602.4
Fugitives	19.6	115.5	22.0	26.0	0	183.1
Total[2,3]	443.2	667.4	724.1	547.8	50.9	2,433.4
Type						
MSS & Events	34.8	124.8	81.0	83.2	0.0	323.8
Uncontrolled[1]	136.4	245.3	234.0	135.9	1.8	753.4
Controlled[1]	259.5	297.3	409.0	328.8	45.9	1,340.5

[1] Uncontrolled and controlled routine emissions. MSS and event emissions are accounted for separately.

[2] Total includes emissions from sites that were not broken down by source or type of emissions.

[3] Total includes fugitive emissions from equipments leaks which are not subject to HECT.

Flares are broken down by the five key sectors that operate flares. The refinery section reported 308.7 tons of VOC in 2008 after having installed all the appropriate flow meters and analyzers. Within the Houston non-attainment zone flare operators reported 1,469.5 tons of VOC all sectors combined.

With this dataset as the baseline, Spectrum requested TCEQ provide flare reported emissions for the calendar years from 2016 through 2020. It is common for the data sets to lag a year due to industry and agency processing time. At the time of the request, 2021 emissions data was not available. TCEQ's Data Disclaimer noted that:

- 2015-2020 point source data obtained from the State of Texas Air Reporting System (STARS) on May 17, 2021. Data maybe subject to revisions and corrections and is a snapshot of information pulled.
- 2020 data is still under review and considered preliminary. Note that 2020 Emission Inventories (EIs) were due March 21, 2021 and not all sites that submitted are reflected in STARS. 2020 Incomplete and preliminary data set as of May 17, 2021.
- Emissions data reported by sites that met the TCEQ reporting requirements as stated in 30 Texas Administrative Code, Section 101.10 for the given year(s).
- Site-wide annual (routine) emissions, emissions events (EE) and scheduled maintenance startup and shutdown (SMSS) emissions for 2015-2020 in tons per year (tpy), and ozone season emissions in pounds per day (ppd).
- Ozone season emissions are required to be reported for sites in El Paso County and counties on or east of 100 W Longitude.
- Flare FIN Data characteristics information provided for active and idle flares.

Overall, Spectrum reviewed the Texas TCEQ EI Datasets, the TCEQ Permitting Table 8 Dataset, and the USEPA's Flare Management Plan Dataset.

The data reveal that there are 2,262 flares in the state of Texas. One should note that this is only the TCEQ database, not to be confused with the number of flares that could be or might be in the Texas Rail Road Commissions (RRC) dataset. Spectrum did not perform a cross reference with the RRC as their dataset is uniquely different.

In summary, there were 2,262 flares noted within the TCEEQ EI for this 5-year period from 2016-2022. Flares reportedly within the area noted as the HRVOC boundary total 454 flares (20.7% of the total state flares). The inventory contains 172 petroleum refinery flares throughout the state associated with SIC Code 2911. These 172 flares are the primary focus of this review because of the various new regulations that come out in 2012 and 2015 relating to them.

Regarding the 172 refinery flares in the state, there are 86 flares within the HRVOC non-attainment area and 86 flares outside the Houston area. For those flares within the HRVOC area, they are counted at only 14 facilities (i.e.: 14 registered entities) suggesting of course that many sites operate with several flares at a facility. Reviewing the publicly available EPA dataset of required Flare Management Plan (FMP. Note: not all refinery flares require an FMP) we see that the state has 124 flares in Texas are in the Federal flare management plan program. Naturally, some flares during the 5-year study period are likely to have been replaced, removed, dropped out, consolidated, or switched out for an enclosed combustor. The Federal EPA dataset identifies approximately 510 refinery flares nationwide where 414 of these are covered or noted being within the 389 FMPs now within the EPA's dataset. Of this EPA dataset, 212 refinery flares nationwide are noted to be operated using a Flare Gas Recovery System (FGRS) of some style. Within Texas, 75 of the 124 refinery flares (nearly 61%) are now reportedly operating with a flare gas recovery system.

Predictions

With the new regulations, extensive flare minimizations assessments, new instrumentation, and large percentage of flares under flare gas recovery, one might develop some expectations of the impacts and possible new outcomes as relates to emissions values. One may optimistically be hoping for:

- 2015's new NSPS Ja rule – resulted in new FGRS installations. One may expect to see statewide SO_2 numbers to decrease for this sector?
- NO_x – with clarification of AP-42 factor, basis now being gross heating value, you'd expect to see results stabilize?
- VOC emissions? One could expect that with more instrumentation, minimization studies, more FGRS, better DRE that the overall VOC emissions from refinery flares should decrease?
- HRVOC emissions – issue is unique. These sites have had a rule with instrumentation and monitoring since 2004. Their 2008 baseline year was an "instrumented year". Further, this area is subject to detailed permitting reviews, emission offsets, VOC credit trading programs, etc. Emission numbers for VOCs within the HRVOC program area should be steady or decreasing?

- COVID in 2020 and various weather events, likely skewed the data – upward or downward?

Observations

Over the time period from 2016 to 2020, considering all flares, state-wide, flare related SO2 emissions decreased from 17,000 tons per year (tpy) to 9,000 tpy. For the refinery group, there is very little discernable change over this time period. There is possibly a little regulatory trend or bump and fall that could be discerned if one remembers that NSPS Subpart Ja was issued in 2012. The final effective date for Subpart Ja was in 2015; however, some refineries weren't quite ready for that target date and they obtained a 1-year extension. It is likely now that on a site-by-site basis, the actual refinery SO2 emission values are probably based on the actual analytical and actual flow meter. One could certainly perform further review of the 1,000 tons of reported refinery flare emissions to try to figure out who are these remaining companies to see how they compare to each other and to their peers. Spectrum's purpose here is not to focus on any particular company, but to keep it high level. But as a reminder, the dataset is by flare. It is likely that the SO2 emissions from the upstream sector flares far outweigh the refinery sector by nearly 4:1.

Chart – All Flares Statewide – SO2 Emissions

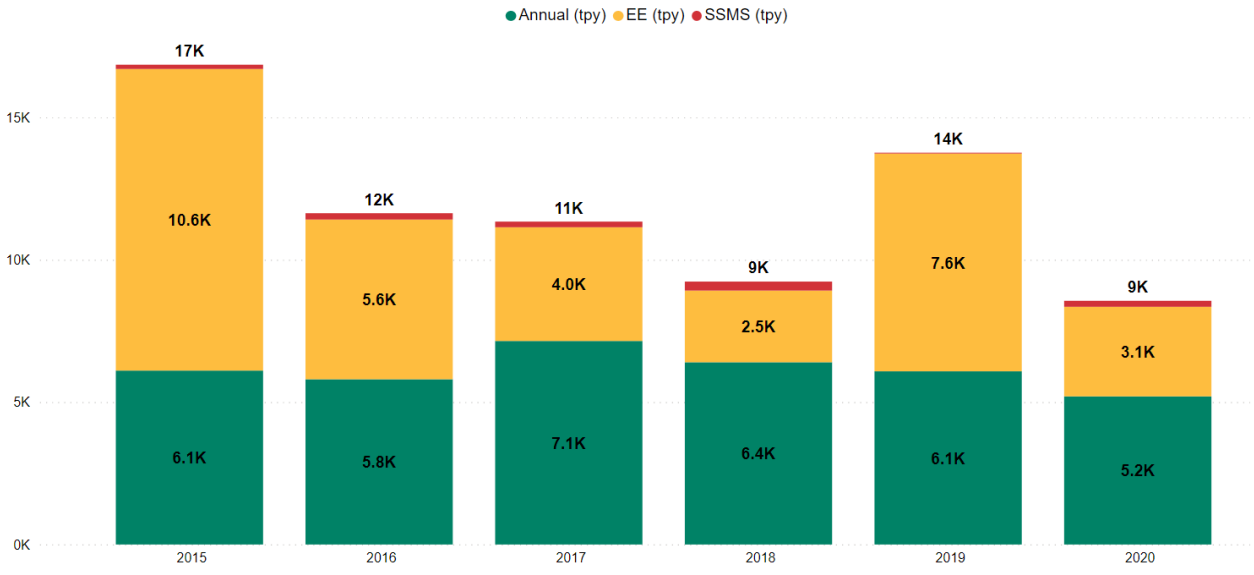
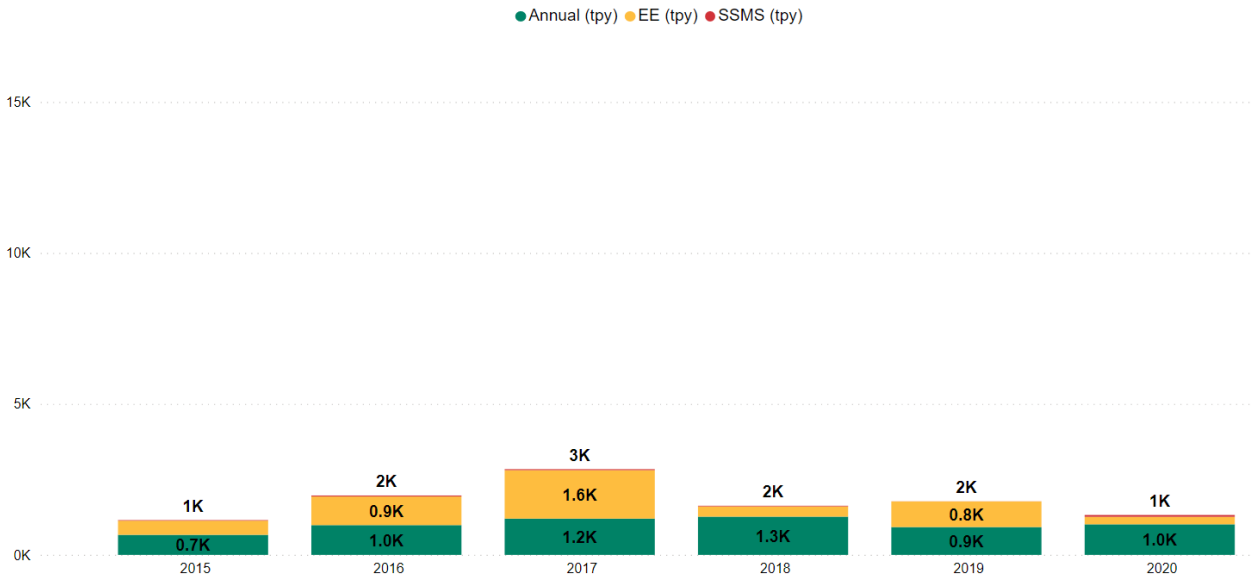


Chart – Refinery Flares – SO2 Emissions



Considering NOx reported emissions, one may recall that the AP-42 emissions factor was clarified by USEPA in 2015 and again in 2018 to clearly state the basis for the calculation is now on the flare gas gross heating value. The TCEQ inventory doesn't include an annualized production factor. Further, the NOx factor is 0.068 lbs. per MMBTU so it is not based on volume of the total flare stream's flow. Generically, the trend for routine statewide flare emissions is upward. It may be that it is for a variety of reasons. For the refinery sector, there is definitely an upward trend with NOx emissions increasing from 406 tpy to 638 tpy over the study period.

Chart – All Flares Statewide – NOx Emissions

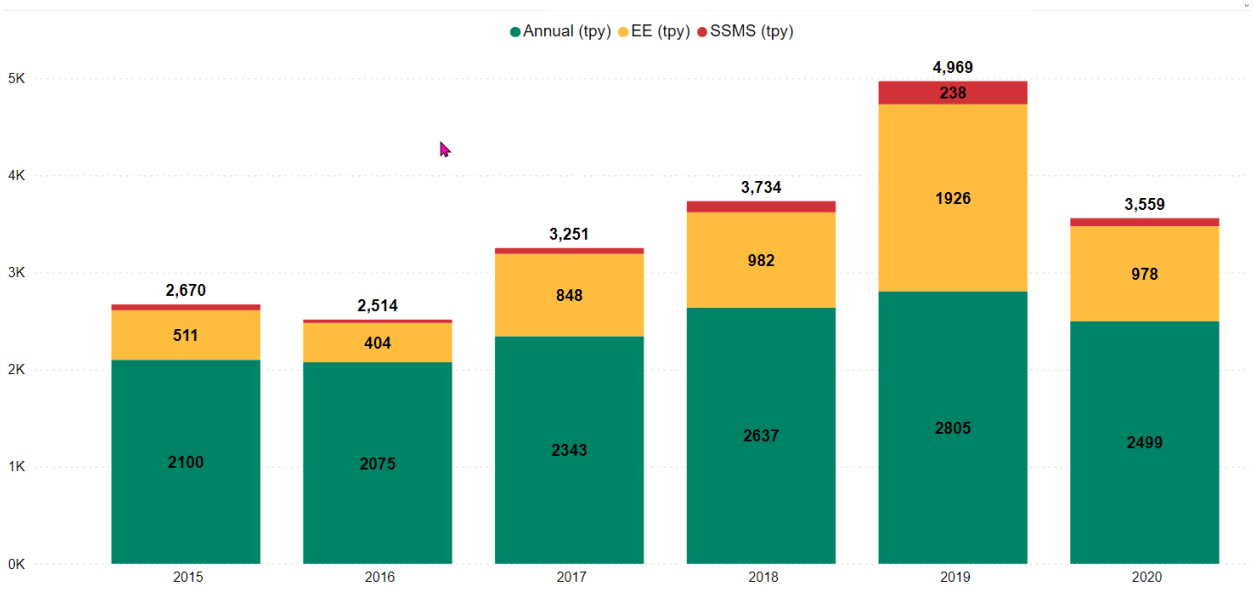
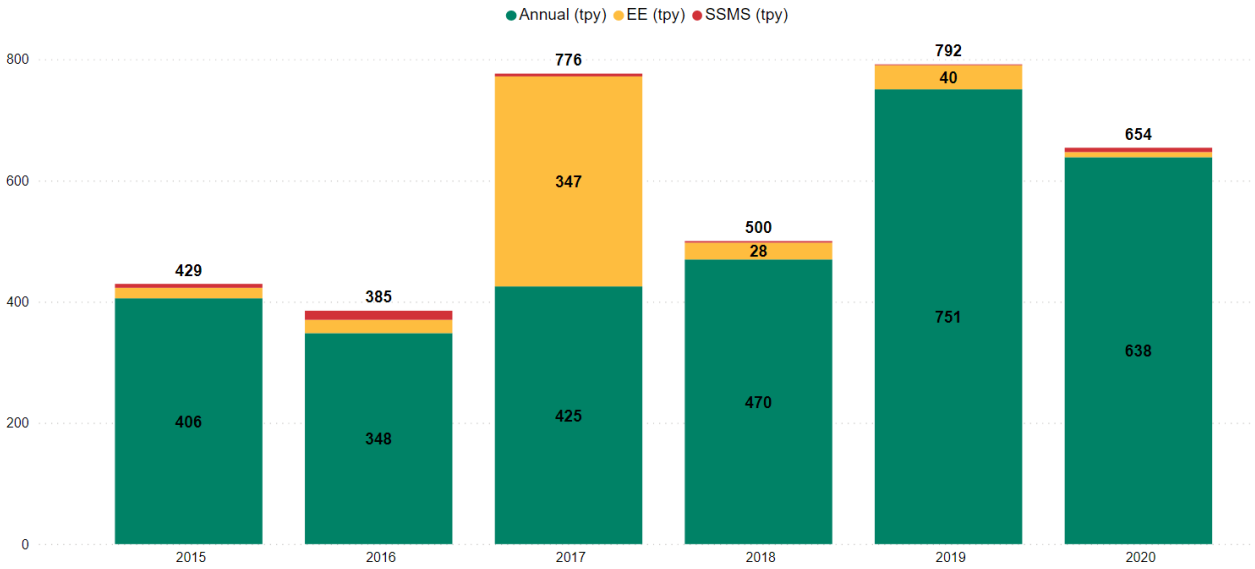


Chart – Refinery Flares – NOx Emissions



Considering VOC reported emissions from all flares statewide, the picture becomes difficult to assess. Routine flare emissions seem to remain steady for the non-HRVOC locations and dropped in 2020, possibly due to a drop-off in fracking rates, but that is not substantiated within this dataset. The large increase in flare related emission events is surely alarming, particularly in 2019. It is most significant that the VOC emissions from all flares have increased within the HRVOC area. Recalling that the refinery flares are evenly split with 86 flares in the HRVOC area and 86 flares outside of HRVOC, it is more surprising to see the HRVOC Emissions at 875 tpy VOC exceed the non-HRVOC flare emissions of 365 tpy VOC. More alarming is the comparison of the current trend and new reported all sectors HRVOC values at 2,493 tpy which has grown from 1,469 tpy in 2008 (now up 170%) and for the refinery group in particular, up from 306.7 tpy to 875 tpy (now up 285%).

Chart – All HRVOC and All Flares Statewide – VOC Emissions

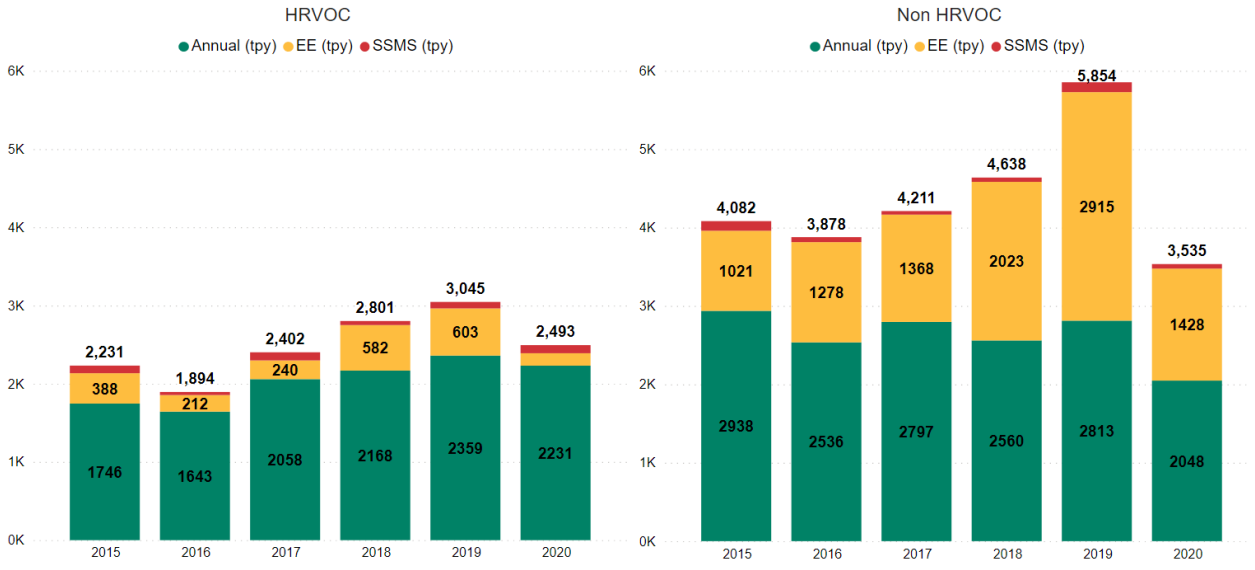
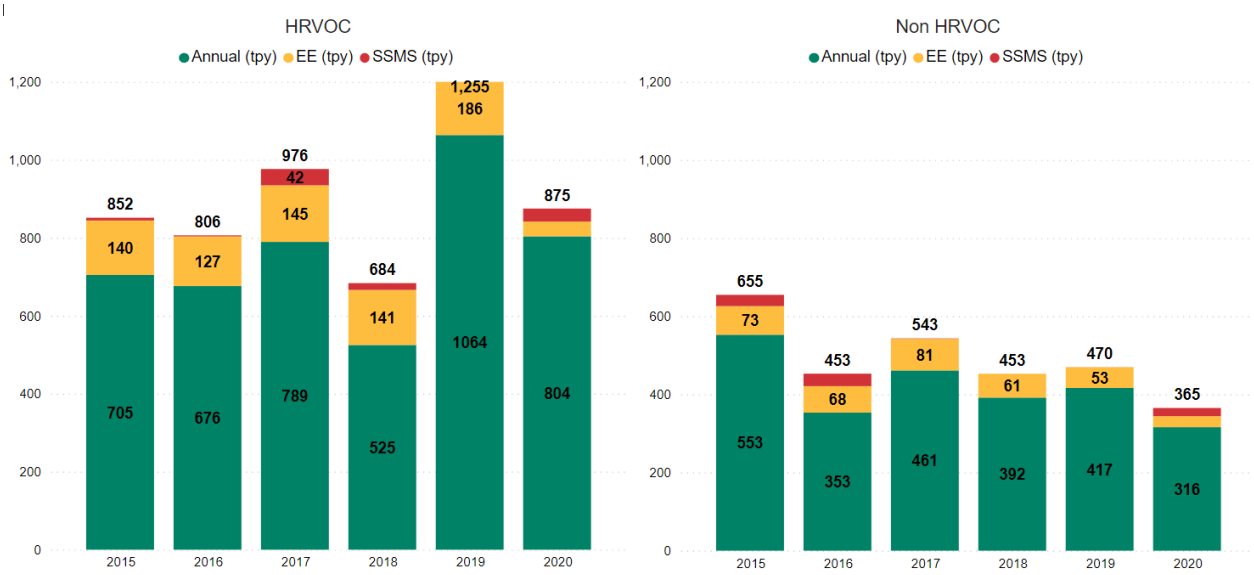


Chart – Refinery HRVOC and Refinery Flares Statewide – VOC Emissions



Conclusions

Following nearly a decade of flare performance inquiry, modeling, and testing in the early 2000's, new USEPA flare regulations have been enacted for the petroleum refinery sector in 2012 and 2015. The stated objective of these new regulations was the decrease of emissions such as sulfur dioxide (SO_2) and an improvement of combustion efficiency directed at reductions in volatile organic compounds (VOC). With six years of speciated emissions data now available from the Texas Commission on Environmental Quality (TCEQ) as well as other publicly available sources, an introductory review of the impact of these new regulations was assessed.

It is still confounding how one could nearly double overall HRVOC emissions from flares in and around Houston during this time period. One could assert that industry may have expanded and added more flares; however, the TCEQ and the HRVOC emission credits program ought to have been tracking these emissions better. The datasets are very complex. Spectrum has identified just a few duplicates, but not nearly enough to account for raising up the flare emissions to these levels. The data sets today are likely the best in history since most flare information is now form new instrumentation and no longer relies solely on estimates or factors. For 2020, there are general emission reductions that likely are production-related effects. The upstream oil and gas sector likely had a production decline, pandemic issues persisted, and there were multiple weather-related issues in Texas and the Gulf Coast which had some hurricanes, more shutdowns that normal. One may have anticipated seeing more increases in MSS emissions or in the emissions events.

Spectrum recommends far more research into this area to assess the positive impacts of the new flare regulations now under effect and planned for the future.

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