United States et al. v. Toledo Refining Company LLC
(N.D. Ohio)

APPENDIX A

EMISSION REDUCTIONS FROM FLARES AND CONTROL OF FLARING EVENTS

WHEREAS the Covered Flares that are subject to this Appendix A are all Steam-Assisted Flares; none are Air-Assisted;

WHEREAS TRC has undertaken waste gas minimization projects in recent years;

Part A: Definitions

A1. The definitions set forth in the Consent Decree shall apply for purposes of this Appendix A. For purposes of this Appendix A to the Consent Decree, the following definitions shall also apply:

a. "Ambient Air" shall mean that portion of the atmosphere, external to buildings, to which persons have access.

b. "Barrels per day" or "bpd" shall mean barrels per calendar day.

c. "BTU/scf" shall mean British Thermal Unit per standard cubic foot.

d. "Capable of Receiving Sweep, Supplemental, and/or Waste Gas" shall mean, for a Flare, that the flow of Sweep, Supplemental, and/or Waste Gas is/are not prevented from being directed to the Flare by means of an isolation device such as closed valves, blinds, or stopples.

e. "Covered Flare" shall mean each of the following Flares:

- Plant 4 Flare
- Plant 9 Flare

Both Covered Flares are Elevated, Steam-Assisted Flares.

f. "Elevated Flare" shall mean a Flare that supports combustion at a tip that is situated at the upper end of a vertical conveyance (*e.g.*, pipe, duct); the combustion zone is elevated in order to separate the heat generated by combustion from people, equipment, or structures at grade level.

g. "External Utility Loss" shall mean a loss in the supply of electrical power or other third-party utility to the Toledo Refinery that is caused by events occurring outside the boundaries of the Toledo Refinery, excluding utility losses due to an interruptible utility service agreement.

h. "In Operation" or "Being In Operation" or "Operating," with respect to a Flare, shall mean any and all times that Sweep, Supplemental, and/or Waste Gas is or may be vented to a Flare. A Flare that is In Operation is Capable of Receiving Sweep, Supplemental, and/or Waste Gas unless all Sweep, Supplemental, and Waste Gas flow is prevented by means of an isolation device such as closed valves, blinds, or stopples.

i. "KSCFH" or "kscfh" shall mean thousand standard cubic feet per hour.

j. "Malfunction" shall mean, as specified in 40 C.F.R. Part 60.2, "any sudden, infrequent, and not reasonably preventable failure of air pollution control equipment, process equipment, or a process to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions." In any dispute under this Appendix A involving this definition, TRC shall have the burden of proving all of the following:

(1) The excess emissions were caused by a sudden, unavoidable breakdown of technology, beyond the control of the owner or operator;

(2) The excess emissions (a) did not stem from any activity or event that could have been foreseen and avoided, or planned for, and (b) could not have been avoided by better operation and maintenance practices;

(3) To the maximum extent practicable the air pollution control equipment or processes were maintained and operated in a manner consistent with good practice for minimizing emissions;

(4) Repairs were made in an expeditious fashion when the operator knew or should have known that applicable emission limitations were being exceeded. Off-shift labor and overtime must have been utilized, to the extent practicable, to ensure that such repairs were made as expeditiously as practicable;

(5) The amount and duration of the excess emissions (including any bypass) were minimized to the maximum extent practicable during periods of such emissions;

(6) All possible steps were taken to minimize the impact of the excess emissions on Ambient Air quality;

(7) All emission monitoring systems were kept in operation if at all possible;

(8) The owner or operator's actions during the period of excess emissions were documented by properly signed, contemporaneous operating logs, or other relevant evidence;

(9) The excess emissions were not part of a recurring pattern indicative of inadequate design, operation, or maintenance; and

(10) The owner or operator properly and promptly notified the appropriate regulatory authority.

k. "Monitoring System Malfunction" shall mean any sudden, infrequent, and not reasonably preventable failure of instrumentation or a monitoring system to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not Monitoring System Malfunctions. In any dispute under this Consent Decree involving this definition, TRC shall have the burden of proving all of the following:

(1) The instrument or monitoring system downtime was caused by a sudden, unavoidable breakdown of technology, beyond the control of the owner or operator;

(2) The instrument or monitoring system downtime (a) did not stem from any activity or event that could have been foreseen and avoided, or planned for, and (b) could not have been avoided by better operation and maintenance practices;

(3) To the maximum extent practicable the air pollution control equipment or processes were maintained and operated in a manner consistent with good practice for minimizing emissions;

(4) Repairs were made in an expeditious fashion when the operator knew or should have known that applicable emission limitations were being exceeded. Off-shift labor and overtime must have been utilized, to the extent practicable, to ensure that such repairs were made as expeditiously as practicable;

(5) The amount and duration of the instrument or monitoring system downtime was minimized to the maximum extent practicable;

(6) The owner or operator's actions during the period of instrument or monitoring system downtime were documented by properly signed, contemporaneous operating logs, or other relevant evidence; and

(7) The instrument or monitoring system downtime was not part of a recurring pattern indicative of inadequate design, operation, or maintenance.

l. "Net Heating Value Analyzer" or "NHV Analyzer" shall mean an instrument capable of measuring the Net Heating Value of Flare Vent Gas in BTU/scf. The sample extraction point of a Net Heating Value Analyzer may be located upstream of the introduction of Supplemental and/or Sweep and/or Flare Purge Gas if the composition and flow rate of any such Supplemental and/or Sweep and/or Flare Purge Gas is a known constant and if this constant then is used in the calculation of the Net Heating Value of the Flare Vent Gas.

m. "Portable Flare" shall mean a Steam-Assisted or Air-Assisted Flare that is not permanently installed that receives Waste Gas that has been redirected to it from a Covered Flare.

n. "Prevention Measure" shall mean an instrument, device, piece of equipment, system, process change, physical change to process equipment, procedure, or program to minimize or eliminate flaring.

o. "SCFD" or "scfd" shall mean standard cubic feet per day.

p. "SCFH" or "scfh" shall mean standard cubic feet per hour.

q. "SCFM" or "scfm" shall mean standard cubic feet per minute.

r. "Smoke Emissions" shall have the definition set forth in Section 3.5 of Method 22 of 40 C.F.R. Part 60, Appendix A. For purposes of this Consent Decree, Smoke Emissions may be either documented by a video camera or determined by an observer knowledgeable with respect to the general procedures for determining the presence of Smoke Emissions per Method 22.

s. "Standard Conditions" shall mean a temperature of 68 degrees Fahrenheit and a pressure of 1 atmosphere (29.92 inches Hg). Unless otherwise expressly set forth in this Appendix, Standard Conditions shall apply.

t. "Steam-Assisted Flare" shall mean a Flare that utilizes steam piped to a Flare tip to assist in combustion.

u. "Visible Emissions" shall mean five minutes or more of Smoke Emissions during any two consecutive hours.

v. "Waste Gas" shall mean the mixture of all gases from facility operations that is directed to a Flare for the purpose of disposing of the gas. "Waste Gas" does not include gas introduced to a Flare exclusively to make it operate safely and as intended; therefore, "Waste Gas" does not include Pilot Gas, Total Steam, Assist Air, or the minimum amount of Flare Sweep Gas and Flare Purge Gas that is necessary to perform the functions of Flare Sweep Gas and Flare Purge Gas. "Waste Gas" also does not include the minimum amount of gas introduced to a Flare to comply with regulatory and/or enforceable permit requirements regarding the combustible characteristics of Combustion Zone Gas; therefore, "Waste Gas" does not include Flare Supplemental Gas. Depending upon the instrumentation that monitors Waste Gas, certain compounds (hydrogen, nitrogen, oxygen, carbon dioxide, carbon monoxide, and/or water (steam)) that are directed to a Flare for the purpose of disposing of these compounds may be excluded from calculations relating to Waste Gas flow. The circumstances in which such exclusions are permitted are identified in the applicable provisions of this Appendix.

A2. For purposes of this Appendix A, the following terms shall have the definitions set forth in 40 C.F.R. § 63.641:

- Assist Air
- Assist Steam
- Center Steam
- Combustion Zone
- Combustion Zone Gas
- Flare
- Flare Purge Gas
- Flare Sweep Gas
- Flare Supplemental Gas
- Flare Vent Gas
- Lower Steam
- Net Heating Value
- Perimeter Assist Air
- Pilot Gas
- Premix Assist Air
- Total Steam
- Upper Steam

Part B: Flaring Limitations

A3. Limitation on Flaring at the Toledo Refinery: Initial Limit.

a. On and after the following dates, TRC shall comply with the following limitation on flaring from all Covered Flares and Portable Flares (if any):

i. Refinery-Wide 365-day Rolling Average. By no later than September 15, 2018, TRC shall comply with the following Refinery-wide, long-term limit: 899,379 scfd of Waste Gas on a 365-day rolling average basis, rolled daily. The first complete 365-day average compliance period shall end 365 days after September 15, 2018.

ii. The rolling average period shall include only the prior 365 days when any Covered Flare or Portable Flare was/were In Operation.

Each exceedance of the 365-day rolling average limit shall constitute one day of violation. An exceedance of the limit shall not prohibit ongoing refinery operations.

b. The limitation set forth in Subparagraph A3.a was calculated using the equation set forth in Subparagraph A4.a. Appendix A1.2 sets forth the

actual calculation. The "*Toledo Ref. Crude Capacity*" was taken from the "Total Operable" atmospheric crude oil distillation capacity, in barrels per calendar day, found in Part 5, Code 401, of the Form EIA-820 that TRC submitted to the Energy Information Agency ("EIA") for the 2018 report year. The value reported was 172,800 barrels per calendar day. A copy of that Form is included in Appendix A1.2. The "*Toledo Complexity*" and "*Industry Avg Complexity*" were calculated pursuant to the methodology set forth in Appendix A1.1.

Nothing in this Appendix or Consent Decree shall be construed to restrict TRC from requesting and securing from the State of Ohio an increase in the limitation set forth in Paragraph A.3., as may have been adjusted pursuant to the provisions of Paragraph A.4., following termination of this Consent Decree pursuant to the provisions of Section XX, provided, however, that nothing in this Paragraph or Consent Decree shall be construed to relieve TRC of an obligation to evaluate, under applicable Prevention of Significant Deterioration and Nonattainment New Source Review requirements, any increase in a Refinery-Wide limit on flaring or any increase in flaring at the Toledo Refinery.

A4. Limitation on Flaring at the Toledo Refinery: Requesting an Increase in the Limit.

a. TRC Request. Once per calendar year commencing no sooner than 2 years after Date of Entry, TRC may submit a request to EPA to increase the limitation on flaring set forth in Subparagraph A3.a.i. TRC may request an increase in the limit, and EPA will approve such an increase, only if the request is based on post-Lodging changes in crude capacity and/or complexity that are or will be permitted by the State of Ohio and only if the changes in crude capacity and/or complexity result in a new limit that is higher by at least 20% than the limit set forth in Subparagraphs A3.a.i. In any such request, TRC shall propose a new limit (hereafter referred to as "New Limit Based on Projections") based upon the following equation:

$$\text{Refinery Flaring} \leq 500{,}000 \text{ scfd} \times \frac{\textit{Toledo Ref. Crude Cap.}}{100{,}000 \text{ bpd}} \times \frac{\textit{Toledo Complexity}}{\textit{Industry Avg Complexity}}$$

Nothing in this Paragraph or Consent Decree shall be construed to relieve TRC of an obligation to evaluate, under applicable Prevention of Significant Deterioration and Nonattainment New Source Review requirements, any increase in a Refinery-Wide limit on flaring or any increase in flaring at the Toledo Refinery.

b. For purposes of Subparagraph A4.a, the following shall apply:

i. The items in italics are variables that will change over time.

ii. The *Toledo Ref. Crude Capacity* shall be determined as follows:

(1) **If the post-Lodging modification does not affect the Refinery's crude capacity then:** use the Atmospheric Crude Oil Distillation Capacity, in barrels per calendar day, that the Refinery reported under "Total Operable" capacity on Part 5, Code 401, of the Applicable Form EIA-820. The definition of "Applicable Form EIA-820" is found in the "Definitions" section of Appendix A1.1. To the extent that the "Parts" or "Codes" on Form EIA-820 change in the future, the intent of the Parties is that the "Parts" and "Codes" of future forms that correspond most closely to those found on the Form EIA-820 for Report Year 2018 (see Attachment 2 to Appendix A1.1) will be used; or

(2) **If the post-Lodging modification does affect the Refinery's crude capacity then:** use the projected, new capacity set forth in the air permit application(s) for the post-Lodging modification.

iii. *Toledo Complexity* shall be calculated in accordance with Equation 1 of Appendix A1.1. TRC shall certify the accuracy of the projected crude capacity and/or process unit capacities used to support the calculations.

iv. The *Industry Average Complexity* shall be calculated in accordance with Equation 2 of Appendix A1.1.

c. EPA Response to Request. EPA shall evaluate any request under Subparagraph A4.a on the basis of consistency with that Subparagraph. If EPA does not act on TRC's request within 90 days of submission, TRC may invoke the accelerated dispute resolution provisions of Subsection XII.B of this Decree.

d. The New Limit Based on Projections shall take effect, if ever, beginning on the later of the date that EPA approves the request or a dispute is resolved in TRC's favor or the date(s) specified in the modification permit(s).

e. In the event that TRC amends, modifies or withdraws the air permit application(s) that is/are the basis for the New Limit(s) Based on Projections requested pursuant to Subparagraph A4.a in a manner that affects the limit(s) calculation(s), TRC shall, within 15 days of amending, modifying, or withdrawing its air permit application(s), revise or withdraw its request under Subparagraph A4.a. To the extent that TRC revises, rather than withdraws, its request under Subparagraph A4.a, the 90-day deadline under Subparagraph A4.c for EPA's response to the revised request shall commence upon the date of EPA's receipt of TRC's revised request.

f. Consequences of a Mistake in Projected Capacities.

i. By no later than 30 days after the Startup of the permitted modifications, TRC shall determine whether the projected "*Toledo Ref. Crude Capacity*" or the projected capacities for new or modified units that TRC relied upon pursuant to Subparagraphs A4.b.ii and/or b.iii, respectively, were or are different from the actual capacities that TRC has or will report to the EIA after the Startup of the permitted modification. If there are differences, TRC shall re-calculate the flaring limitation using the actual capacities that TRC has or will report to the EIA (hereafter referred to as "New Limit Based on Actuals").

ii. If the New Limit Based on Actuals that TRC calculates under Subparagraph A4.f.i is greater than the New Limit Based on Projections that TRC calculated under Subparagraph A4.a, then no further action shall be required and the New Limit Based on Projections shall remain in effect.

iii. If the New Limit Based on Actuals that TRC calculates under Subparagraph A4.f.i is less than the New Limit Based on Projections that TRC calculated under Subparagraph A4.a, then by no later than 30 days after the Startup of the permitted modifications, TRC shall: *(1)* commence complying with the New Limit Based on Actuals; and *(2)* submit the revised, recalculated New Limit Based on Actuals to EPA. After submission to EPA, TRC shall consult with EPA about the New Limit Based on Actuals and secure EPA's approval.

iv. Stipulated Penalties. If Subparagraph A4.f.iii applies, then by no later than 60 days after the Startup of the permitted modifications, the New Limit Based on Actuals identified in the submission to EPA under Subparagraph A4.f.iii*(2)* shall apply and form the basis for determining compliance for purposes of the stipulated penalty provisions of Subparagraph 84.a. If EPA

disapproves the New Limit Based on Actuals, the New Limit Based on Actuals shall continue to apply for purposes of stipulated penalties until such time as another limitation either is agreed upon between EPA and TRC or a dispute is resolved that sets forth a revised limitation.

A5. Limitations on Flaring at the Toledo Refinery: Meaning and Calculation of "Waste Gas" Flow for Purposes of the Limitation on Flaring. For purposes of the meaning and calculation of "Waste Gas" flow in the limitation on flaring in Subparagraph A3.a.i, and any revised limitation on flaring developed pursuant to Paragraph A4, the following shall apply:

a. To the extent that TRC has instrumentation capable of calculating the volumetric flow rate of hydrogen, nitrogen, oxygen, carbon monoxide, carbon dioxide, and/or water (steam) in the Waste Gas, the contribution of all measured flows of any of these elements/compounds may be excluded from the Waste Gas flow rate calculation.

b. Flows during all periods (including but not limited to normal operations and periods of Startup, Shutdown, Malfunction, process upsets, relief valve leakages, utility losses due to an interruptible utility service agreement, and emergencies arising from events within the boundaries of the Refinery), except those expressly described in the next sentence, shall be included. Flows that could not be prevented through reasonable planning and are in anticipation of or caused by a natural disaster, act of war or terrorism, or External Utility Loss may be excluded from the calculation of flow rate.

c. Except for hydrogen, nitrogen, oxygen, carbon monoxide, carbon dioxide, and/or water (steam) contributions to the flow rate that are excluded by virtue of instrumentation measuring these flows, for any flow that TRC does not include in a computation, TRC shall submit the following information in the semi-annual report due under Part F of this Appendix A: a description of the event that resulted in the exclusion; the date(s) and duration(s) of the flows caused by the event; the estimated VOC and SO_2 emissions during the event; whether flows from the event are anticipated to persist after the notice, and if so, for how long; and the measures taken or to be taken to prevent or minimize the flows, including, for future anticipated flow, the schedule by which those measures will be implemented.

Part C: Flare Combustion Efficiency

A6. Early Compliance with RSR Flaring Requirements. At any time on or after September 30, 2018, that Supplemental, Sweep, and/or Waste Gas is routed to a Covered Flare or Portable Flare (if any), TRC shall comply with each applicable requirement in 40 C.F.R. §§ 63.670-63.671 for that Flare. Subsequent to the January 30, 2019 effective date of

40 C.F.R. §§ 63.670-63.671, EPA may assess stipulated penalties and take other potential enforcement action under this Consent Decree for violations of applicable requirements of 40 C.F.R. §§ 63.670-63.671 only with respect to the following provisions: 40 C.F.R. §§ 63.670(e) (combustion zone operating limits), 63.670(i) (flare vent gas, steam assist and air assist flow monitoring), 63.670(j) (flare vent gas composition monitoring), 63.670(l) (calculation methods for determining flare vent gas net heating value), and 63.670(m) (calculation methods for determining combustion zone net heating value). Potential violations of all other provisions of the RSR Flaring Requirements shall not be subject to stipulated penalties or other enforcement actions under this Consent Decree after January 30, 2019. Nothing in this Paragraph, however, shall be construed to limit the authority of the United States to seek legal or equitable relief outside of this Consent Decree for any violation of the RSR Flaring Requirements.

A7. Instrumentation and Monitoring Systems: Operation. TRC shall operate each of the instruments and monitoring systems required in 40 C.F.R. § 63.670(i) and (j) in accordance with the applicable provisions of 40 C.F.R. § 63.670(i) and (j), provided that, except for periods of Monitoring System Malfunctions, repairs associated with Monitoring System Malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments), TRC must collect data on a continuous basis at all times when the Covered Flare that the instrument and/or monitoring system is associated with is Capable of Receiving Sweep, Supplemental, and/or Waste Gas.

Part D: Recordkeeping

A8. TRC shall keep all records to document compliance with the requirements of this Appendix in accordance with Section XIII (Information Collection and Retention) of this Consent Decree. All records will be retained for five years, except for data recorded by any video camera required pursuant to 40 C.F.R. §§ 63.670 and 63.671, which will be retained for one year from the date of recording. Upon request by EPA, TRC shall make all such documents available to EPA.

Part E: Reporting

A9. Compliance Status Reports. In the reports due under Section VIII (Recordkeeping and Reporting), TRC shall submit the following information relating to Appendix A:

a. A progress report on the implementation of the requirements in this Appendix A;

b. A description of any problems anticipated with respect to meeting the requirements of this Appendix A;

c. Monitoring equipment/instrument downtime; exceedances of emission standards; as described in Paragraph A10;

d. For the semi-annual report due on August 30 of each year, annual emissions data, as described in Paragraph A11;

e. Any additional matters that TRC believes should be brought to the attention of EPA.

A10. Monitoring Instrument/Equipment Downtime and Failure to Meet Emission Standard. TRC shall provide a summary of the following, per Covered Flare or per Portable Flare (if applicable) per calendar quarter within each semiannual report submitted pursuant to Section VII of this Consent Decree (hours shall be rounded to the nearest tenth):

a. Monitoring Instrument/Equipment Downtime. The total number of hours of downtime of each monitoring instrument/equipment required to comply with 40 C.F.R. §§ 63.670 and 63.671, expressed as both an absolute number and a percentage of time the Covered Flare or Portable Flare (if any) that the instrument/equipment monitors is In Operation and Capable of Receiving Sweep, Supplemental, and/or Waste Gas;

b. Monitoring Instrument/Equipment Downtime. An identification of the periods of downtime by date, time, cause (including Monitoring System Malfunction or maintenance), and, if the cause is asserted to be a Monitoring System Malfunction, the corrective action taken;

c. Inapplicability of Emissions Standard. The total number of hours, expressed as both an absolute number of hours and a percentage of time during a calendar quarter in which the Combustion Zone Net Heating Value Standard in 40 C.F.R. § 63.670(m) was not applicable because Supplemental, Sweep, and/or Waste Gas was/were not being vented to the Covered Flare or Portable Flare (if any) for at least 15 minutes; for purposes of Subparagraph A11.d, all remaining hours shall be termed "Hours of Applicability";

d. Failure to Meet Emissions Standard. During the Hours of Applicability, the total number of hours, expressed as both an absolute number of hours and a percentage of time the Covered Flare or Portable Flare (if any) was receiving Supplemental, Sweep, and/or Waste Gas for at least 15 minutes, of a failure to meet the Combustion Zone Net Heating Value Standard in 40 C.F.R. § 63.670(m); a specific identification of each block period that failed to meet that standard, by time and date; the cause of the failure, and if the cause is asserted to be a Malfunction, an explanation and any corrective actions taken.

e. Flaring Limitation Exceedances.

i. For any Waste Gas flows that are excluded from the calculation of flow rate because they are asserted to be based on one or more of the excludible events identified in Subparagraph A5.b, the information required in Subparagraph A5.c;

ii. An identification of each calendar day in which the limitation on flaring set forth in Paragraph A3 was exceeded;

iii. The cause of the exceedance; and

iv. If the cause is asserted to be a Malfunction, an explanation and any corrective actions taken.

A11. Emissions Data. In the semi-annual report that is submitted on August 30 of each year, TRC shall provide, for each Covered Flare and Portable Flare (if applicable), for the prior calendar year, the calculated amount of emissions of the following compounds (in tons per year): VOCs, SO_2, H_2S, CO_2e, and methane.

APPENDIX A1.1

APPENDIX A1.1

EQUATIONS AND METHODOLOGY TO CALCULATE REFINERY-SPECIFIC AND INDUSTRY-AVERAGE COMPLEXITY USING NELSON COMPLEXITY INDEX

DEFINITIONS:

"Applicable EIA Annual Refinery Publication" shall mean the Annual EIA Refinery Publication that was the most recent one posted on EIA's website prior to a refinery's request for an increase in flaring caps.

"Applicable Form EIA-820" shall mean the Form EIA-820 that forms the source for the requesting refinery's capacity information that is summarized and compiled in the Applicable Annual EIA Refinery Publication.

> *For example, if a refinery requests an increase in flaring caps in March of 2020, the "Applicable Form E1A-820," is the Form EIA-820 that the Refinery submitted prior to February 15, 2019, for its capacities as of January 1, 2019, (and not the Form EIA-820 that the Refinery submitted prior to February 15, 2020, for its capacities as of January 1, 2020). This is because the Applicable EIA Annual Refinery Publication is the one published in June of 2019 (i.e., the last one published prior to March of 2020).*

"Applicable O&GJ Refining Survey" shall mean the survey that is published in December of the year prior to the year of the Applicable EIA Annual Refinery Publication. If the O&GJ Refining Survey for the year prior to the year of the Applicable EIA Annual Refinery Publication does not have the capacity for a specific process, then the "Applicable O&GJ Refining Survey" shall mean the most recent survey that did include that information.

> *For example, if the Applicable EIA Annual Refinery Publication is the one published in June of 2019, then the Applicable O&GJ Refinery Survey is the one published in December of 2018 for capacities as of January 1, 2019.*

"EIA" shall mean the United States Energy Information Agency.

"EIA Annual Publication of the Number and Capacity of Petroleum Refineries" or "EIA Annual Refinery Publication" shall mean the information posted on EIA's website on approximately June 21 of each year that compiles and summarizes the data submitted on the Form EIA-820s that each refinery submits prior to February 15 of that year. As of October 2018, the most recent Annual EIA Refinery Publication *(i.e.,* the one from June of 2018) is found at https://www.eia.gov/petroleum/data.php#refining. A printout of this publication is Attachment 1 to this Appendix A1.1.

APPENDIX A1.1

"Form EIA-820" shall mean the annual report that each refinery is required to submit to the EIA prior to February 15 of each year. The "Report Year" of a Form EIA-820 refers to the capacities that exist as of January 1 of the "Report Year." A copy of TRC's Form EIA-820 for 2018 is Attachment 2 to this Appendix A1.1.

"Oil & Gas Journal Worldwide Refining Survey" or "O&GJ Refining Survey" shall mean the survey that the Oil & Gas Journal publishes in December of each year that lists refining capacities as of January 1 of the following year. A copy of the national refining capacities listed in the December 1, 2014 O&GJ Refining Survey for January 1, 2015 is Attachment 3 to this Appendix A1.1. The relevant United States capacities are highlighted in yellow on the fourth page of Attachment 3.

REFINERY COMPLEXITY. The complexity of the Refinery is to be calculated using the following formula:

$$Complexity = \sum_{n=1}^{i} \left(\frac{NCI_i \times CAP_i}{CAP_{DIST}} \right) \qquad \textbf{\textit{Equation 1}}$$

Where:

NCI_i	=	The 2011 Nelson Complexity Index Coefficient shown in Table 1 below for Process Unit i
CAP_i	=	The throughput capacity for the Refinery's Process Unit i, in barrels per calendar day[1], which shall be determined as follows: (a) for a Process Unit that is not new or modified and for which the Applicable EIA Annual Refinery Publication lists total US throughput for that process, the capacity, in barrels per calendar day[1], that the Refinery reported for Process i on Part 6 or 7[2] of the Applicable Form EIA-820. If the Refinery did not report the capacity of Process i in "barrels per calendar day," but instead reported it in "barrels per stream day," then "barrels per stream day" will be converted to "barrels per calendar day" by multiplying "barrels per stream day" by the following factors: 0.95 for a vacuum distillation unit and 0.9 for all other units; or (b) for a process unit that is not new or modified, if and only if the Applicable EIA Annual Refinery Publication does not list total US throughput capacity for that process unit, then the Refinery's capacity for that process unit, in barrels per calendar day, listed in the Applicable O&GJ Refining Survey; or (c) for a Process Unit that is new or modified, where the new or modified capacity was not reported on the Applicable Form EIA-820, the projected new or modified unit capacity that is set forth in the air permit application(s) for the post-Lodging modification; and, (d) For Polymerization capacity, which is no longer reported in the O&GJ Refining Survey, and is not reported in the EIA Annual Refinery Publication, TRC shall use 2,970,

[1] Except that hydrogen capacity is reported in million cubic feet per day (mmcfd) and sulfur capacity is reported in short tons per day.

[2] The references to particular "Parts" or "Codes" of Form EIA-820 are to the Parts and Codes as they exist for the Form EIA-820 that was used for Report Year 2018. See Attachment 2. To that extent that the "Parts" or "Codes" on Form EIA-820 are changed in the future, the intent of the Parties is that the "Parts" and "Codes" of future forms that correspond most closely to those found on the Form EIA-820 for Report Year 2018 will be used.

		unless this number is reported in either report in the future, in which case it shall use the procedures in (a)-(c); and, (e) For Hydrogen Plant capacity, TRC shall use 110, which is the capacity of Linde's Oregon, Ohio hydrogen plant in million cubic feet of hydrogen per day, because the Linde hydrogen plant is tied into TRC's flare system. If Linde's capacity changes, TRC shall use the new capacity of the Linde plant
CAP_{DIST}	=	The Refinery's Atmospheric Crude Oil Distillation Capacity, in barrels per calendar day, which shall be determined as follows: (a) if the post-Lodging modification does not affect the crude capacity, the Atmospheric Crude Oil Distillation Capacity, in barrels per calendar day, that the Refinery reported under "Total Operable" capacity on Part 5, Code 401/1 of the Applicable Form EIA-820; or (b) if the post-Lodging modification does affect crude capacity, the projected, new capacity set forth in the air permit application(s) for the post-Lodging modification.

INDUSTRY AVERAGE COMPLEXITY: The Industry Average Complexity is to be calculated using the following formula:

$$Industry_Average_Complxity = \sum_{n=1}^{i} \left(\frac{NCI_i \times ICAP_i}{ICAP_{DIST}} \right) \qquad \textbf{\textit{Equation 2}}$$

Where:

NCI_i = The 2011 Nelson Complexity Index Coefficient shown in Table 1 below for Process Unit i

$ICAP_i$ = Total US throughput capacity, in barrels per calendar day[1], for Process Unit i which shall be determined as follows:

(a) from the Applicable EIA Annual Refinery Publication, the total US capacity of Process Unit i in barrels per calendar day[1]. For the total US capacity of those process units that the EIA lists only in "barrels per stream day" and not in "barrels per calendar day," the "barrels per stream day" shall be converted to "barrels per calendar day" by multiplying "barrels per stream day" by the following factors: 0.95 for a vacuum distillation unit and 0.9 for all other units.[3]

(b) if and only if the Applicable EIA Annual Refinery Publication does not list a total US throughput capacity for a process unit that the Refinery operates, then the total US throughput capacity for that process unit listed in the Applicable O&GJ Refining Survey.

(c) As long as Polymerization continues to be excluded from both the EIA Annual Refinery Publication and the O&GJ Refining Survey, TRC shall use 72,740, which reflects the amount reported in the 2015

[3] For example, for catalytic reforming, the total US capacity as of January 1, 2018, is 3,463,906 barrels per calendar day. See Attachment 1 at page 2 (blue highlight). Note that the capacity for catalytic reforming on page 1 of Attachment 1 should not be used because that value (3,801,313) is listed in "barrels per stream day," not bpcd. For vacuum distillation, the total US capacity for 2018 is 9,076,249 barrels per stream day. See id. at page 1 (green highlight). This figure would be converted to 8,622,436 barrels per calendar day (9,076,249 x .95).

O&GJ Refining Survey, plus TRC's current polymerization capacity as used in the calculation of the Toledo Refinery's complexity.

(d) For Hydrogen, after determining the amount reported using the procedure in (a), TRC shall add the amount of hydrogen plant capacity for Linde's Oregon, Ohio facility, as used in the calculation of the Toledo Refinery's complexity, unless this amount was included in TRC's EIA report, in which case it shall use only the amount determined using the procedure in (a).

$ICAP_{DIST}$ = From the Applicable EIA Annual Refinery Publication, the total "Operable" US Atmospheric Crude Oil Distillation Capacity, in barrels per calendar day.[4]

Table 1: 2011 Nelson Complexity Index Coefficients

Refining Process	NCI Coefficients
Distillation Capacity	1.00
Vacuum Distillation	1.30
Thermal Processes	2.75
Coking	7.50
Catalytic Cracking	6.00
Catalytic Reforming	5.00
Catalytic Hydrocracking	8.00
Catalytic Hydrorefining	2.50
Catalytic Hydrotreating	2.50
Alkylation	10.00
Polymerization	10.00
Aromatics	20.00
Isomerization	3.00
Lubes	60.00
Asphalt	1.50
Hydrogen (MCFD)	1.00
Oxygenates	10.00
Sulfur Extraction	240.00

[4] Total Operable US Atmospheric Crude Oil Distillation Capacity (total $ICAP_{DIST}$) as of January 1, 2018, is 18,598,497 barrels per calendar day. See Attachment 1 at page 1 (yellow highlight).

APPENDIX A1.1

ATTACHMENT 1

U.S. Energy Information Administration

PETROLEUM & OTHER LIQUIDS

OVERVIEW | DATA | ANALYSIS & PROJECTIONS | GLOSSARY › | FAQS ›

Number and Capacity of Petroleum Refineries

Area: U.S. **Period:** Annual (as of January 1)

Show Data By: Data Series / Area	Graph / Clear	2011	2012	2013	2014	2015	2016	View History
Number of Operable Refineries								
Total Number of Operable Refineries	☐	148	144	143	142	140	141	1982-2016
Operating	☐	137	134	139	139	137	139	1982-2016
Idle	☐	11	10	4	3	3	2	1982-2016
Atmospheric Crude Oil Distillation Capacity								
Operable (Barrels per Calendar Day)	☐	17,736,370	17,322,178	17,823,659	17,924,630	17,967,088	18,317,036	1982-2016
Operating	☐	16,937,024	16,744,291	16,775,658	17,730,200	17,767,588	18,165,136	1982-2016
Idle	☐	799,346	577,887	1,048,001	194,430	199,500	151,900	1982-2016
Operable (Barrels per Stream Day)	☐	18,953,189	18,560,350	18,971,643	19,064,210	19,134,102	19,507,602	1982-2016
Operating	☐	18,109,882	17,945,443	17,863,443	18,853,210	18,916,102	19,345,102	1982-2016
Idle	☐	843,307	614,907	1,108,200	211,000	218,000	162,500	1982-2016
Downstream Charge Capacity (Barrels per Stream Day)								
Vacuum Distillation	☐	8,650,243	8,679,643	8,938,093	8,987,443	8,979,485	9,073,285	1982-2016
Thermal Cracking	☐	2,672,376	2,763,356	2,877,456	2,958,556	2,974,508	2,983,265	1982-2016
Total Coking	☐	2,645,776	2,736,756	2,850,856	2,931,956	2,947,908	2,956,665	1987-2016
Delayed Coking	☐	2,486,876	2,577,856	2,691,956	2,773,056	2,789,008	2,797,765	1987-2016
Fluid Coking	☐	158,900	158,900	158,900	158,900	158,900	158,900	1987-2016
Visbreaking	☐	16,000	16,000	16,000	16,000	16,000	16,000	1987-2016
Other (Including Gas Oil)	☐	10,600	10,600	10,600	10,600	10,600	10,600	1987-2016
Catalytic Cracking - Fresh Feed	☐	6,219,721	6,032,512	6,089,366	6,031,866	6,012,478	6,052,183	1982-2016
Catalytic Cracking - Recycle Feed	☐	95,640	84,890	84,390	75,890	75,890	75,690	1982-2016
Catalytic Hydro-Cracking	☐	1,855,600	1,879,600	2,080,700	2,208,231	2,305,400	2,317,600	1982-2016
Distillate	☐	540,100	596,500	621,300	686,131	687,000	687,400	2004-2016
Gas Oil	☐	1,170,500	1,161,100	1,337,400	1,400,100	1,491,400	1,503,200	2004-2016
Residual	☐	145,000	122,000	122,000	122,000	127,000	127,000	2004-2016
Catalytic Reforming	☐	3,720,613	3,641,813	3,758,347	3,759,323	3,740,763	3,743,063	1982-2016
Low Pressure	☐	2,390,950	2,347,850	2,486,550	2,541,250	2,615,750	2,658,740	1987-2016
High Pressure	☐	1,329,663	1,293,963	1,271,797	1,218,073	1,125,013	1,084,323	1987-2016
Catalytic Hydrotreating/Desulfurization	☐	16,682,897	16,565,262	16,860,186	17,094,540	17,323,829	17,482,804	1982-2016
Naphtha/Reformer Feed	☐	4,441,323	4,360,593	4,522,347	4,564,683	4,595,573	4,614,073	1987-2016
Gasoline	☐	2,578,782	2,519,082	2,582,182	2,639,235	2,727,384	2,773,434	2004-2016
Heavy Gas Oil	☐	2,809,298	2,877,138	2,895,938	2,949,638	2,972,438	2,971,838	1987-2016
Distillate Fuel Oil	☐	6,113,846	6,063,001	6,237,071	6,348,036	6,420,486	6,508,211	1987-2016
Kerosene/Jet Fuel	☐	1,484,850	1,489,750	1,544,850	1,539,250	1,563,850	1,570,850	2004-2016
Diesel Fuel	☐	3,917,611	3,981,411	4,108,581	4,251,931	4,297,181	4,375,906	2004-2016
Other Distillate	☐	711,385	591,840	583,640	556,855	559,455	561,455	2004-2016
Residual Fuel Oil/Other	☐	739,648	745,448	622,648	592,948	607,948	615,248	1987-2016
Residual Fuel Oil								

		241,000	246,000	246,000	246,000	246,000	246,000	2004-2016
Other		498,648	499,448	376,648	346,948	361,948	369,248	2004-2016
Fuels Solvent Deasphalting		382,750	374,550	367,550	369,550	370,050	370,550	1987-2016
Downstream Charge Capacity (Barrels per Calendar Day)								
Catalytic Reforming		3,346,457	3,246,874	3,405,017	3,419,407	3,392,641	3,385,049	2010-2016
Total Coking		2,396,787	2,499,293	2,596,369	2,686,917	2,686,299	2,650,839	1987-2016
Catalytic Cracking - Fresh Feed		5,794,214	5,611,191	5,681,643	5,616,015	5,583,169	5,596,552	1987-2016
Catalytic Hydro-Cracking		1,687,745	1,706,540	1,887,024	2,034,689	2,123,431	2,121,715	1987-2016

Click on the source key icon to learn how to download series into Excel, or to embed a chart or map on your website.

- = No Data Reported; -- = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

Notes: Idle refineries represent refineries where distillation units were completely idle but not permanently shutdown as of January 1 of the year. See Definitions, Sources, and Notes link above for more information on this table.

Release Date: 06/22/2016
Next Release Date: 06/30/2017

U.S. Energy Information Administration

PETROLEUM & OTHER LIQUIDS

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Production Capacity of Operable Petroleum Refineries

(Barrels per Stream Day, Except Where Noted)

Area: U.S. Period: Annual (as of January 1)

Show Data By: Product / Area	Graph / Clear	2011	2012	2013	2014	2015	2016	View History
Alkylate		1,262,443	1,246,875	1,269,361	1,266,352	1,267,246	1,286,012	1982-2016
Aromatics		297,311	296,911	317,511	296,511	316,411	323,275	1982-2016
Asphalt & Road Oil		828,003	795,687	740,587	743,987	709,987	732,587	1982-2016
Isomers		703,042	687,860	736,913	738,580	757,286	755,245	1982-2016
Isobutane		213,449	191,467	191,760	192,960	189,346	192,085	1982-2016
Isopentane & Isohexane		487,993	494,793	544,953	545,420	567,740	562,960	1982-2016
Isooctane		1,600	1,600	200	200	200	200	2009-2016
Lubricants		242,840	242,340	240,740	240,240	265,340	273,140	1982-2016
Marketable Petroleum Coke		778,114	823,090	867,139	882,931	887,478	889,491	1982-2016
Hydrogen (Million Cu. Ft. per Day)		3,082	3,215	3,047	3,094	3,102	2,997	1982-2016
Sulfur (Short Tons per Day)		35,483	36,663	39,478	41,375	41,266	41,343	1987-2016

Click on the source key icon to learn how to download series into Excel, or to embed a chart or map on your website.

- = No Data Reported, -- = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

Notes: Hydrogen production capacity includes capacity of hydrogen plants on refinery grounds. See Definitions, Sources, and Notes link above for more information on this table.

Release Date: 06/22/2016
Next Release Date: 06/30/2017

APPENDIX A1.1

ATTACHMENT 2

U.S. Energy Information Administration

OMB No. 1905-0165
Expiration Date: 05/31/2016
Version No.:2013.01

FORM EIA-820
ANNUAL REFINERY REPORT
REPORT YEAR 2016

This report is **mandatory** under the Federal Energy Administration Act of 1974 (Public Law 93-275). Failure to comply may result in criminal fines, civil penalties and other sanctions as provided by law. For further information concerning sanctions and data protections see the provision on sanctions and the provision concerning the confidentiality of information in the instructions. **Title 18 USC 1001 makes it a criminal offense for any person knowingly and willingly makes to any Agency or Department of the United States any false, fictitious, or fraudulent statements as to any matter within its jurisdiction.**

PART 1. RESPONDENT IDENTIFICATION DATA

EIA ID NUMBER: 1357813101

If any Respondent Identification Data has changed since the last report, enter an "X" in the box: ☐

Company Name: Toledo Refining Company LLC
Doing Business As:
Site Name: Toledo Refinery
Terminal Control Number (TCN):

Physical Address (e.g., Street Address, Building Number, Floor, Suite):
1819 Woodville Road
City Oregon **State:** OH **Zip:** 43616 -

Mailing Address of Contact (e.g., PO Box, RR): If the physical and mailing addresses are the same, only complete the physical address.
1601 Woodville Road
City Toledo **State:** OH **Zip:** 43605 -

Contact Name: Ron Market
Phone No.: (419) 698-7462 **Ext:**
Fax No.: (866) 675-4476
Email address: Ron.Market@pbfenergy.com

PART 2. SUBMISSION/RESUBMISSION INFORMATION

If this is a resubmission, enter an "X" in the box: ☐

A completed form must be received by February 16th of the designated report year.

Forms may be submitted using one of the following methods:

Email: OOG.SURVEYS@eia.gov

Fax: (202) 586-1076

Secure File Transfer:
https://signon.eia.doe.gov/upload/noticeoog.jsp

Questions? Call: 202-586-6281

Comments: Explain any unusual or substantially different aspects of your current year's operations that affect the data reported. For example, note new processing units, major modifications or retirement of processing units, sale of refinery, etc. (To separate one comment from another, press ALT+ENTER)

U.S. Energy Information Administration

OMB No. 1905-0165
Expiration Date: 05/31/2016
Version No.:2013.01

FORM EIA-820
ANNUAL REFINERY REPORT
REPORT YEAR 2016

EIA ID NUMBER: 1357813101 **RESUBMISSION:**

PART 3. FUEL, ELECTRICITY, AND STEAM PURCHASED & CONSUMED AT THE REFINERY DURING 2015

Item	Code	Quantity Used As Fuel or Feedstock	Item	Code	Quantity Used as Fuel
Natural Gas (million standard cubic feet):			Coal (thousand short tons)	109	
Fuel	105	8102	Purchased Electricity (million kWh)	114	448
Hydrogen Feedstock	107		Purchased Steam (million pounds)	113	890

PART 4. REFINERY RECEIPTS OF CRUDE OIL BY METHOD OF TRANSPORTATION DURING 2015 (Thousand Barrels)

Source	Code	Pipelines	Tankers	Barges	Tank Cars	Trucks	Total[1]
Domestic	010	26576			1429	4025	32030
Foreign	020	23241			36		23277

[1] Total Domestic and Total Foreign Refinery Receipts (Codes 010 and 020) **must equal the sum** of the comparable refinery receipts on the Form EIA-810, "Monthly Refinery Report," filed for January through December 2015.

PART 5. ATMOSPHERIC CRUDE OIL DISTILLATION CAPACITY AS OF JANUARY 1

Atmospheric Crude Oil Distillation Capacity	Code	Barrel per Calendar Day[2]	Barrels per Stream Day
2016: Operating	399	160000	188000
Idle	400		
Total Operable	401	160000	188000
2017: Operable	501		188000

[2] Barrels per Calendar Day Operating, Idle and Total Operable Capacity (Codes 399, 400 and 401) **must match** the comparable capacity numbers reported on the Form EIA-810, "Monthly Refinery Report," filed for January 2016.

Independent Statistics & Analysis
U.S. Energy Information Administration

OMB No. 1905-0165
Expiration Date: 05/31/2016
Version No.:2013.01

FORM EIA-820
ANNUAL REFINERY REPORT
REPORT YEAR 2016

EIA ID NUMBER: 1357813101 **RESUBMISSION:**

PART 6. DOWNSTREAM CHARGE CAPACITY AS OF JANUARY 1

Downstream Charge Capacity	Code	2016 Barrels per Calendar Day	2016 Barrels per Stream Day	2017 Barrels per Stream Day
Vacuum Distillation	402			
Thermal Cracking:				
Visbreaking	403			
Fluid Coking (incl. Flexicoking)	404			
Delayed Coking	405			
Other (incl. Gas Oil)	406			
Catalytic Cracking:				
Fresh Feed	407	71000	82000	82000
Recycled	408			
Catalytic Hydrocracking:				
Distillate	439	39000	52000	52000
Gas Oil	440			
Residual	441			
Desulfurization (including Catalytic Hydrotreating):				
Naphtha/Reformer Feed	426		45900	45900
Gasoline	420		72000	72000
Kerosene and Jet	421		32000	32000
Diesel Fuel	422			
Other Distillate	423			
Residual	424			
Heavy Gas Oil	413			
Other	425			
Catalytic Reforming:				
Low Pressure	430			
High Pressure	431	43200	51800	51800
Fuels Solvent Deasphalting	432			

PART 7. PRODUCTION CAPACITY AS OF JANUARY 1 (Barrels per Stream Day, Except Where Noted)

Production Capacity	Code	2016 Barrels per Stream Day	2017 Barrels per Stream Day
Alkylates	415	9950	9950
Aromatics	437	10800	10800
Asphalt and Road Oil	931		
Isobutane (C4)	044	8000	8000
Isopentane (C5), Isohexane (C6)	438		
Isooctane (C8)	635		
Lubricants	854		
Petroleum Coke - Marketable	021		
Hydrogen (million cubic ft. per day)	091		
Sulfur (short tons per day)	435	116	116

APPENDIX A1.1

ATTACHMENT 3

2014 Worldwide Refining Survey

Leena Koottungal
Survey Editor/News Writer

All figures in barrels per calendar day (b/cd)

All figures are as of January 1, 2015

LEGEND
Numbers identify processes in table

Coking
1. Fluid coking
2. Delayed coking
3. Other

Thermal process
1. Thermal cracking
2. Visbreaking

Catalytic cracking
1. Fluid
2. Other

Catalytic reforming
1. Semiregenerative
2. Cyclic
3. Continuous regen.
4. Other

Catalytic hydrocracking
1. Distillate upgrading
2. Residual upgrading
3. Lube oil manufacturing
4. Other

c. Conventional (high pressure) hydrocracking: (>100 barg or 1,450 psig)
m. Mild to moderate hydrocracking (<100 barg or 1,450 psig)

Catalytic hydrotreating
1. Pretreatment of cat reformer feeds
2. Other naphtha desulfurization
3. Naphtha aromatics saturation
4. Kerosine/jet desulfurization
5. Diesel desulfurization
6. Distillate aromatics saturation
7. Other distillates
8. Pretreatment of cat cracker feeds
9. Other heavy gas oil hydrotreating
10. Resid hydrotreating
11. Lube oil polishing
12. Post hydrotreating of FCC naphtha
13. Other

Alkylation
1. Sulfuric acid
2. Hydrofluoric acid

Polymerization/Dimerization
1. Polymerization
2. Dimerization

Aromatics
1. BTX
2. Hydrodealkylation
3. Cyclohexane
4. Cumene

Isomerization
1. C_4 feed
2. C_5 feed
3. C_5 and C_6 feed

Oxygenates
1. MTBE
2. ETBE
3. TAME
4. Other

Hydrogen
Production:
1. Steam methane reforming
2. Steam naphtha reforming
3. Partial oxidation
   a. Third-party plant

Recovery:
4. Pressure swing adsorption
5. Cryogenic
6. Membrane
7. Other

NOTES

A Previously listed as Interoil
B Previously listed as Lion Oil Co.
C Previously listed as US Oil & Refining Co.
D Idle
E Previously listed as North Atlantic Refining Ltd.
F New
G Previously listed as Northern Tier Energy LLC
H Previously listed as ERG Raffinerie Mediterranee North
I Previously listed as Shell Refining (Australia) Pty. Ltd.

Capacity definitions:
Capacity expressed in barrels per calendar day (b/cd) is the maximum number of barrels of input that can be processed during a 24-hour period, after making allowances for the following: (a) Types and grades of inputs to be processed, (b) Types and grades of products to be manufactured, (c) Environmental constraints associated with refinery operations, (d) Scheduled downtime such as mechanical problems, repairs, and slowdown. Capacity expressed in barrels per stream day (b/sd) is the amount a unit can process when running at full capacity under optimal feedstock and product slate conditions. An asterisk (*) beside a refinery location indicates that the number has been converted from b/sd to b/cd using the conversion factor 0.95 for crude and vacuum distillation units and 0.9 for all downstream cracking and conversion units.

Hydrogen:

Hydrogen volumes presented here represent either generation or upgrading to 90+% purity.

Catalytic reforming:
1. Semiregenerative reforming is characterized by shutdown of the reforming unit at specified intervals, or at the operators's convenience, for in situ catalyst regeneration.
2. Cyclic regeneration reforming is characterized by continuous or continual regeneration of catalyst in situ in any one of several reactors that can be isolated from and returned to the reforming operation. This is accomplished without changing feed rate or octane.
3. Continuous regeneration reforming is characterized by the continuous addition of this regenerated catalyst to the reactor.
4. "Other" includes nonregenerative reforming (catalyst is replaced by fresh catalyst) and moving-bed catalyst systems.

REFINERY REMOVALS

Name	Location	Country	Crude b/cd	Reason
Caltex Australia Ltd.	Kurnell	Australia	135,000	Converting to fuel import terminal
Flint Hills Resources	North Pole	Alaska	132,050	Costs, contamination
Gulf Atlantic Operations	Alabama	US	20,000	
Italiana Energia E Servizi SPA (c)	Mantova	Italy	69,420	Converting to products logistics hub
LyondellBasell Industries	Berre l'Etang	France	105,000	Converting to terminal
Murco Petroleum Ltd.	Milford Haven	Wales, UK	135,000	Converting to terminal
Pertamina	Pangakalan Brandan, North Sumatra	Indonesia	4,750	

Worldwide Refineries—Capacities as of Jan. 1, 2015

Country	No. of refineries	Crude	Charge capacity, b/cd: Vacuum distillation	Coking	Thermal operations	Catalytic cracking	Catalytic reforming	Catalytic hydrocracking	Catalytic hydrotreating	Alkylation	Production capacity, b/cd: Pol./Dim.	Aromatics	Isomerization	Lubes	Oxygenates	Hydrogen (MMcfd)	Coke (tonnes per day)	Sulfur (tonnes per day)	Asphalt
Albania	2	30,000	10,500	12,000	—	—	3,500	—	17,400	—	—	600	—	700	—	6.5	700	60	—
Algeria	5	493,000	10,894	—	—	—	88,900	—	81,950	—	—	—	—	—	—	—	—	—	—
Angola	1	39,000	2,500	—	—	—	1,900	—	6,600	—	—	—	—	—	—	—	—	—	950
Argentina	10	611,175	248,365	91,233	31,420	134,910	56,630	17,000	175,600	4,300	520	—	12,700	7,290	2,600	19.0	3,810	108	12,700
Australia	5	541,148	146,865	—	—	155,843	120,053	17,557	402,360	15,869	5,909	1,000	34,777	—	—	68.9	—	140	5,000
Austria	1	203,892	78,805	—	12,580	28,281	22,525	57,752	134,627	—	—	—	22,195	—	3,278	62	—	180	1,130
Azerbaijan	2	398,978	137,200	38,529	—	57,750	24,466	—	67,492	930	—	—	—	16,200	—	—	1,400	—	5,000
Bahrain	1	253,650	198,170	—	21,600	35,100	13,500	54,000	76,500	—	3,330	—	—	—	—	164.0	—	340	8,730
Bangladesh	1	33,000	4,000	—	10,000	—	1,800	1,200	2,000	—	—	—	—	—	—	2.0	—	—	—
Belarus	2	493,323	105,800	—	60,000	44,000	92,000	30,000	262,100	—	—	2,785	4,500	3,760	—	22.8	—	85	9,630
Belgium	4	727,750	240,502	—	26,448	130,025	104,318	—	699,785	16,441	—	—	0	—	4,183	99.0	—	971	26,500
Bolivia	2	52,350	2,200	—	—	—	12,100	—	6,899	—	—	—	—	—	—	14.0	—	—	—
Bosnia	1	240,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brazil	13	1,917,325	810,140	115,319	9,800	505,287	24,386	—	284,446	6,290	—	—	—	20,009	6,460	126.0	6,974	771	27,100
Brunei	1	8,600	—	—	—	—	5,700	—	—	—	—	—	—	—	—	—	—	—	—
Bulgaria	1	115,240	49,900	—	20,600	23,300	4,060	—	64,200	2,600	—	2,000	—	—	790	10.3	—	63	1,500
Cameroon	1	37,000	—	—	—	—	6,500	—	16,140	—	—	—	—	—	—	—	—	—	—
Canada	17	2,007,500	645,930	60,100	122,000	491,318	354,447	234,478	1,396,304	70,203	19,240	62,689	53,590	3,000	—	405.0	2,635	1,889	66,000
Chile	3	233,150	85,050	13,860	13,860	50,540	26,460	50,400	—	910	—	—	8,510	—	1,580	—	656	90	—
China	56	7,542,000	407,448	240,000	—	719,753	277,813	337,000	578,000	18,700	—	55,600	—	18,000	2,100	178	4,020	1,526	—
China, Taiwan	4	1,310,000	248,500	51,000	—	217,900	115,000	25,000	672,500	14,200	—	14,000	26,000	15,300	11,266	341.0	4,522	3,745	15,270
Colombia	5	290,850	141,000	—	52,000	90,000	—	—	19,800	2,100	2,100	2,200	—	1,400	—	18.0	—	—	—
Congo, Republic of	1	21,000	8,000	—	—	—	2,000	2,000	3,500	—	—	—	—	—	—	—	—	—	—
Costa Rica	1	24,000	600	—	6,500	—	1,200	—	2,000	—	—	—	—	—	—	—	—	—	—
Croatia	3	250,317	87,040	5,000	23,526	51,002	49,368	12,264	68,256	—	—	9,438	5,431	470	—	—	200	123	—
Cuba	4	301,400	75,700	—	—	14,700	20,000	—	55,850	—	—	—	—	—	—	5.0	—	—	1,080
Czech Republic	3	194,000	78,870	—	14,000	24,000	27,470	36,000	103,780	—	—	660	7,210	2,180	2,160	112.0	—	144	10,880
Denmark	2	169,400	22,000	—	68,000	—	21,990	—	42,760	—	—	—	6,400	—	—	—	—	—	8,000
Dominican Republic	2	50,000	—	—	—	—	8,200	—	20,813	—	—	—	—	—	—	0.6	—	—	—
Ecuador	3	176,000	45,300	—	31,500	18,000	12,800	—	24,500	—	—	—	—	—	—	—	—	—	—
Egypt	9	726,250	95,200	39,270	—	—	62,240	33,500	207,802	9,000	—	1,584	10,700	4,441	—	62.5	1,601	290	4,623
El Salvador	1	22,000	4,000	—	—	—	3,000	—	15,500	—	—	—	—	—	—	—	—	—	—
Eritrea	1	14,564	2,219	—	—	—	1,465	—	2,742	—	—	—	—	—	—	—	—	—	—
Finland	2	260,575	146,085	—	34,420	56,690	50,060	90,110	298,325	7,750	600	—	—	5,280	5,730	160.0	—	540	6,800
France	9	1,405,913	551,257	—	110,996	245,382	194,867	76,740	1,105,393	27,969	—	2,887	25,800	29,590	2,702	132.0	—	1,358	19,272
Gabon	1	24,000	—	—	9,220	—	1,400	—	9,430	—	—	—	—	—	—	—	—	—	—
Germany	15	2,187,899	1,089,483	104,260	308,375	349,847	401,702	191,719	1,968,510	30,849	8,301	68,245	94,226	14,220	13,172	682.6	3,863	2,917	58,980
Ghana	1	45,000	—	—	—	14,000	65,000	—	—	—	—	—	—	—	—	—	—	—	—
Greece	4	423,000	152,000	—	49,000	75,550	49,200	43,900	361,635	2,400	1,720	9,100	23,650	3,500	3,940	23.5	—	519	16,950
Hungary	1	161,000	77,500	16,900	14,000	24,000	29,600	—	120,700	3,300	—	12,000	3,500	6,100	1,200	76.2	600	226	6,300
India	23	4,642,761	811,986	169,625	72,600	508,405	51,673	165,600	203,638	85,000	—	6,619	—	8,240	—	111.7	6,480	290	33,677
Indonesia	7	1,007,075	265,980	32,580	58,860	101,450	92,970	99,720	23,430	16,200	—	—	—	—	—	—	—	—	—
Iran	8	1,167,000	440,400	—	198,800	35,000	135,100	106,500	180,160	—	—	—	—	9,200	—	216.0	—	400	26,800
Iraq	9	637,500	145,000	—	—	—	88,000	74,241	292,000	—	—	—	2,500	9,420	—	64.0	—	—	38,738
Ireland	1	71,000	—	—	—	—	11,000	—	53,600	—	—	—	7,600	—	—	10.3	—	10	—

Worldwide Refineries—Capacities as of Jan.1, 2015

Country	No. of refineries	Charge capacity, b/cd: Crude	Vacuum distillation	Coking	Thermal operations	Catalytic cracking	Catalytic reforming	Cat hydro-cracking	Cat hydro-treating	Production capacity, b/cd: Alkylation	Pol./Dim.	Aromatics	Isomerization	Lubes	Oxygenates	Hydrogen (MMcfd)	Coke (tonnes per day)	Sulfur (tonnes per day)	Asphalt
Israel	2	220,000	118,000	—	66,000	49,500	26,500	—	96,000	—	2,200	—	—	—	750	—	—	—	2,700
Italy	14	2,046,309	750,317	45,000	328,984	321,000	239,169	284,800	1,085,083	40,330	1,500	13,400	92,145	24,000	11,720	300.2	2,046	1,650	12,206
Ivory Coast	1	63,990	23,990	—	—	—	12,330	14,480	27,310	—	—	—	—	—	—	—	—	—	4,330
Jamaica	1	36,000	1,800	—	—	—	3,700	—	23,800	—	—	—	—	—	—	—	—	—	850
Japan	28	4,466,640	1,619,340	123,400	20,000	946,150	763,235	181,690	4,647,210	65,690	5,760	199,157	22,330	34,013	2,978	1,425.4	1,863	9,029	82,370
Jordan	1	90,400	21,500	—	—	4,000	10,900	5,220	17,300	—	—	—	—	—	—	16.0	—	—	4,250
Kazakhstan	3	340,000	121,037	24,997	52,071	38,356	51,586	—	177,890	—	—	—	—	—	—	21.5	1,000	124	8,550
Kenya	1	90,000	1,700	—	—	—	8,260	—	36,000	—	—	—	—	—	—	—	—	—	1,000
Kuwait	3	936,000	327,750	72,000	—	36,000	46,620	115,550	588,780	5,616	—	—	—	—	6,561	741.6	2,800	4,200	—
Kyrgyzstan	1	10,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Liberia	1	15,000	1,000	—	—	—	2,000	—	3,300	—	—	—	—	—	—	—	—	—	200
Libya	5	378,000	3,775	—	—	—	20,250	—	43,330	—	—	—	—	635	—	—	—	—	3,432
Lithuania	1	190,000	89,300	—	28,800	43,200	45,900	—	153,300	—	7,200	—	18,900	—	2,700	25.0	—	320	—
Macedonia	1	50,000	—	—	—	—	10,860	—	22,050	—	—	—	4,390	—	—	—	—	—	—
Malaysia	7	526,832	101,000	24,000	—	39,000	75,070	36,000	216,800	—	—	—	10,800	—	—	147.2	2,245	460	8,000
Martinique	1	17,329	—	—	—	—	2,862	—	14,269	—	—	—	—	—	—	—	—	—	—
Mexico	6	1,540,000	754,000	191,000	—	380,500	279,300	—	926,050	128,456	—	17,000	—	16,600	15,490	183.0	—	—	58,000
Morocco	2	154,901	24,921	—	—	5,040	24,359	—	35,539	—	—	—	—	2,460	—	—	—	—	5,630
Myanmar	3	57,000	4,000	5,200	—	—	—	—	—	—	—	—	—	500	—	—	120	—	—
Netherlands	6	1,194,673	711,604	41,500	91,404	103,731	148,510	197,385	817,899	15,450	—	36,468	8,730	11,600	2,715	358.9	—	1,673	16,500
Netherlands Antilles	1	320,000	195,000	—	80,000	50,000	20,000	—	119,500	9,000	2,000	—	—	12,000	—	54.6	—	300	26,000
New Zealand	1	107,000	38,270	—	—	—	25,840	30,000	104,490	—	—	—	—	—	—	60.0	—	111	5,490
Nicaragua	1	19,950	1,425	—	—	—	2,700	—	14,085	—	—	—	—	—	—	—	—	—	378
Nigeria	4	445,000	124,490	—	—	82,700	70,070	—	109,231	9,870	2,274	291	3,610	3,878	—	—	—	—	14,850
North Korea	2	71,000	—	—	—	—	7,300	—	7,400	—	—	1,000	—	—	1,000	—	—	—	—
Norway	2	319,000	—	23,000	32,000	55,000	34,900	—	126,000	—	11,000	—	3,840	—	—	—	610	20	—
Oman	1	85,000	—	—	—	—	16,000	—	21,000	—	—	—	—	—	—	—	—	—	—
Pakistan	6	182,196	19,815	—	—	—	11,650	—	54,870	—	—	1,400	—	3,800	—	—	—	—	4,200
Papua New Guinea	1	32,000	—	—	—	—	3,500	—	3,500	—	—	—	—	—	—	—	—	—	—
Paraguay	1	7,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Peru	6	192,950	94,000	—	25,700	33,500	2,100	—	2,800	—	—	—	—	—	—	—	—	—	3,800
Philippines	3	276,000	61,000	—	31,000	19,000	51,000	—	184,990	—	—	—	10,000	3,700	—	37.0	—	70	1,200
Poland	4	492,950	265,123	—	—	32,985	67,514	145,908	259,507	3,372	—	10,262	23,194	17,796	2,514	167.0	—	560	33,371
Portugal	2	304,172	87,785	—	36,540	40,500	50,182	9,180	201,537	5,400	—	17,276	—	—	—	85.3	—	252	—
Puerto Rico	1	73,000	34,000	—	—	—	21,000	20,000	21,000	—	—	—	—	—	—	20.0	—	34	—
Qatar	2	338,700	—	—	—	60,000	29,400	20,000	39,350	—	—	—	25,000	—	—	—	—	—	—
Romania	9	461,789	247,593	74,005	26,300	103,579	49,154	—	272,022	2,300	—	12,417	7,213	9,614	2,996	38.9	2,935	156	10,441
Russia	40	5,499,993	2,091,314	94,369	382,593	330,817	748,733	122,256	2,170,966	10,006	1,729	54,697	27,469	82,842	7,175	93.3	3,720	726	210,545
Saudi Arabia	8	2,496,000	445,950	—	191,100	103,600	240,500	135,000	493,460	31,500	—	6,500	33,000	—	3,700	190.7	—	—	—
Senegal	1	25,030	7,160	—	—	—	1,590	—	1,930	—	—	—	—	—	—	—	—	—	—
Serbia & Montenegro	2	214,826	50,583	—	20,340	18,950	18,822	—	50,910	3,070	—	200	—	300	—	0.5	—	59	2,400
Sierra Leone	1	10,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Singapore	3	1,344,500	342,500	—	145,210	80,000	142,470	147,500	742,000	9,000	—	—	—	52,500	1,400	297.0	—	963	39,500
Slovakia	1	115,000	55,000	—	—	18,000	21,000	42,000	87,800	4,500	—	9,250	6,000	2,000	1,500	89.6	—	270	2,600
Slovenia	1	13,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Worldwide Refineries—Capacities as of Jan.1, 2015

		Charge capacity, b/cd								Production capacity, b/cd									
Country	No. of refineries	Crude	Vacuum distillation	Coking	Thermal operations	Catalytic cracking	Catalytic reforming	Cat hydro-cracking	Cat hydro-treating	Alkylation	Pol./Dim.	Aromatics	Isomerization	Lubes	Oxygenates	Hydrogen (MMcfd)	Coke (tonnes per day)	Sulfur (tonnes per day)	Asphalt
South Africa	4	503,000	201,375	26,800	60,000	108,640	77,142	11,774	227,772	9,595	4,940	6,900	12,223	8,000	—	50.2	240	607	7,100
South Korea	6	2,968,500	515,650	19,000	—	367,000	394,000	339,000	1,543,380	48,700	12,800	167,300	—	71,300	15,700	1,472.5	1,200	5,280	86,327
Spain	9	1,427,500	414,245	61,100	149,200	191,300	196,750	131,500	827,630	16,916	—	25,800	36,000	9,600	9,600	300.1	3,565	1,762	26,600
Sri Lanka	1	50,000	24,000	—	12,500	—	5,300	—	19,295	—	—	—	—	—	—	—	—	—	1,000
Sudan	3	121,700	—	—	—	—	1,900	—	8,100	—	—	—	—	—	—	—	—	—	—
Suriname	1	7,000	7,000	—	2,800	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sweden	5	437,000	135,600	—	66,800	29,700	70,660	48,600	268,540	—	3,420	—	28,530	—	—	53.8	—	334	27,460
Switzerland	1	72,000	—	—	—	20,400	12,000	—	33,200	—	3,800	—	6,400	—	—	28.0	—	—	—
Syria	2	239,865	63,135	18,200	22,689	—	31,242	26,410	80,886	—	—	—	11,493	—	—	27.0	500	150	2,223
Tanzania	1	14,900	—	—	2,500	—	2,500	—	4,400	—	—	—	—	—	—	—	—	—	—
Thailand	4	645,000	201,500	—	16,983	90,490	96,770	43,073	466,917	—	—	—	19,596	—	—	33.5	—	420	2,500
Trinidad & Tobago	1	168,000	119,200	—	24,000	24,000	18,000	45,000	41,000	1,200	1,580	—	—	—	1,000	30.0	—	100	—
Tunisia	1	34,000	—	—	—	—	3,300	—	—	—	—	—	—	—	—	—	—	—	—
Turkey	6	663,000	201,767	—	23,590	28,935	65,662	53,820	265,005	—	—	—	14,055	5,870	—	217.5	180	315	20,216
Turkmenistan	2	236,970	91,645	28,568	—	15,151	52,540	—	63,500	1,028	1,223	—	—	2,000	—	—	1,040	—	415
Ukraine	6	879,759	343,002	22,149	17,291	70,100	146,735	7,200	315,013	—	—	3,464	—	500	125	21.5	705	176	12,785
United Arab Emirates	5	773,250	92,870	—	—	34,350	25,875	31,050	158,627	1,140	1,900	—	—	—	—	58.8	—	57	700
United Kingdom	8	1,401,705	682,963	67,850	101,571	347,867	283,866	36,000	1,070,990	67,033	9,500	14,590	85,798	13,999	3,063	133.0	2,400	752	26,000
United States	123	18,024,750	8,068,197	2,692,625	33,520	5,569,316	3,486,029	1,905,050	14,507,177	1,158,072	69,770	344,289	662,793	222,800	29,650	4,271.8	137,666	34,332	488,117
Uruguay	1	50,000	25,000	—	7,000	12,000	12,000	—	23,000	—	—	—	6,000	—	—	—	—	—	—
Uzbekistan	3	224,271	45,671	17,667	9,585	—	23,487	—	30,804	—	—	—	—	9,397	—	—	650	—	4,151
Venezuela	5	1,282,100	585,780	144,900	—	231,800	49,500	—	389,700	65,800	—	2,000	20,700	12,020	12,830	147.8	5,200	1,471	36,000
Vietnam	1	140,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Yemen	2	140,000	10,500	—	—	—	14,500	—	—	—	—	—	—	—	—	—	—	—	3,000
Zambia	1	23,750	2,280	—	—	—	5,320	—	8,550	—	—	—	—	—	—	—	—	—	5,527
Total	643	87,958,735	28,339,811	4,807,005	3,488,176	14,338,190	11,218,277	5,942,828	44,503,370	2,048,055	184,316	1,195,069	1,549,497	812,024	196,328	14,391	208,146	83,518	1,724,524

APPENDIX A1.2

APPENDIX A1.2
Methodology for Calculating Refinery Flaring Limitation

Refinery	*Calculation Basis*	*Refinery Crude Capacity (b/cd)*	*Refinery Complexity*	*US Complexity*	*Refinery/US Complexity*	*365-Day Rolling Average SCFD*
Toledo, OH	EIA/O&GJ (b/cd)[1]	172,800	11.61	11.16	1.04	899,379

Notes:

[1] Data in barrels per calendar day (b/cd) are shown on the next page. US capacities as of 1/1/2018 as taken from US EIA report "U.S. Number and Capacity of Petroleum Refineries" (published 6/25/2018) were used preferentially. See Attachment 1 to Appendix A1.1, along with the corresponding Toledo Refinery capacities as of 1/1/2018 submitted by the Toledo Refinery on Form EIA-820 Annual Refinery Report Parts 5, 6, and 7. See Attachment 2 to Appendix A1.1. Where b/cd data was not available in the EIA report, barrels per stream day (b/sd) data from EIA report were converted to b/cd for some processes using O&GJ factors (0.95 for vacuum distillation and 0.9 for any other processes) where noted. For polymerization capacity, which is not included on the US EIA report, the Oil & Gas Journal Worldwide Refining Survey (published 12/1/2014) calendar day capacity was used for the US capacity, and the Toledo Refinery's capacity, which was not included in that report, was both added to the US capacity and counted as the Toledo Refinery's capacity. See Attachment 3 of Appendix A1.1. For hydrogen capacity, the capacity of the Linde hydrogen plant which is tied into the Toledo Refinery's flare system was added to both the U.S. capacity reported in the US EIA Report "U.S. Number and Capacity of Petroleum Refineries" (published 6/25/2018), and included in the Toledo Refinery's hydrogen capacity.

[2] Nelson Complexity factors are shown on the next page, and are specified in CD Appendix A1.1.

APPENDIX A1.2
Methodology for Calculating Refinery Flaring Limitation

Process	Nelson Complexity Factor	Toledo Refinery Capacity as of 1/1/2018		U.S. Capacity as of 1/1/2018	
		b/cd, except H_2 and S	Source[1, 3]	b/cd, except H_2 and S	Source[1, 2, 5, 6]
Atmospheric Distillation	1.00	172,800	Part 5, Toledo Refinery's 2018 EIA-820, b/cd	18,598,497	EIA Website 2018 Data – No. and Cap., b/cd
Vacuum Distillation[4]	1.30	0	Part 6, Toledo Refinery's 2018 EIA-820, b/sd*0.95	8,622,437	EIA Website 2018 Data – No. and Cap., b/sd*0.95
Coking[4]	7.50	0	Part 6, Toledo Refinery's 2018 EIA-820, b/cd	2,719,950	EIA Website 2018 Data – No. and Cap., b/cd
Catalytic Cracking - Fresh Feed	6.00	73,700	Part 6, Toledo Refinery's 2018 EIA-820, b/cd	5,552,991	EIA Website 2018 Data – No. and Cap., b/cd
Catalytic Cracking - Recycle Feed	6.00	0	Part 6, Toledo Refinery's 2018 EIA-820, b/sd*0.9	69,201	EIA Website 2018 Data – No. and Cap., b/sd*0.9
Reforming	5.00	46,900	Part 6, Toledo Refinery's 2018 EIA-820, b/cd	3,463,906	EIA Website 2018 Data – No. and Cap., b/cd
Hydrocracking	8.00	46,100	Part 6, Toledo Refinery's 2018 EIA-820, b/cd	2,245,934	EIA Website 2018 Data – No. and Cap., b/cd
Hydrotreating	2.50	134,910	Part 6, Toledo Refinery's 2018 EIA-820, b/sd*0.9	15,927,484	EIA Website 2018 Data – No. and Cap., b/sd*0.9
Alkylates	10.00	8,955	Part 7, Toledo Refinery's 2018 EIA-820, b/sd*0.9	1,184,136	EIA Website 2018 Data – Prod. Cap., b/sd*0.9
Hydrogen (mmcfd)	1000	110	Design basis of the Linde plant	3,037	EIA Website 2018 Data, Prod. Cap., mmcfd, plus the Hydrogen Plant Capacity of Linde Gas in Oregon, Ohio, which is tied into TRC's flare system
Sulfur (short tons/day)	240.00	116	Part 7, Toledo Refinery's 2018 EIA-820, t/cd	41,419	EIA Website 2018 Data – Prod. Cap., b/sd*0.9
Thermal Processes (Visbreaking)[4]	2.75	0	Part 6, Toledo Refinery's 2018 EIA-820, b/sd*0.9	14,400	EIA Website 2018 Data – No. and Cap., b/sd*0.9
Polymerization	10.00	2,970	January – October 2017 Actual Production Rate	72,740	O&GJ (12/1/2014), WW Refining - Capacities b/cd, plus TRC's Polymerization Capacity which was not included in this report
Aromatics	20.00	9,720	Part 7, Toledo Refinery's 2018 EIA-820, b/sd*0.9	291,403	EIA Website 2018 Data – Prod. Cap., b/sd*0.9
Isomerization[4]	3.00	0	Part 7, Toledo Refinery's 2018 EIA-820, b/sd*0.9	669,024	EIA Website 2018 Data – Prod. Cap., b/sd*0.9
Lubes[4]	10.00	0	Part 7, Toledo Refinery's 2018 EIA-820, b/sd*0.9	236,106	EIA Website 2018 Data – Prod. Cap., b/sd*0.9
Asphalt[4]	60.00	0	Part 7, Toledo Refinery's 2018 EIA-820, b/sd*0.9	593,104	EIA Website 2018 Data – Prod. Cap., b/sd*0.9
Complexity		**11.61**		**11.16**	

Notes:

[1] Data in barrels per calendar day (b/cd) are shown on the next page. US capacities as of 1/1/2018 as taken from US EIA report "U.S. Number and Capacity of Petroleum Refineries" (published 6/25/2018) were used preferentially. See Attachment 1 to Appendix A1.1, along with the corresponding Toledo Refinery capacities as of 1/1/2018 submitted by the Toledo Refinery on Form EIA-820 Annual Refinery Report Parts 5, 6, and 7. See Attachment 2 to Appendix A1.1. Where b/cd data was not available in the EIA report, barrels per stream day (b/sd) data from EIA report were converted to b/cd for some processes using O&GJ factors (0.95 for vacuum distillation and 0.9 for any other processes) where noted. For polymerization capacity, which is not included on the US EIA report, the Oil & Gas Journal Worldwide Refining Survey (published 12/1/2014) calendar day capacity was used for the US capacity, and the Toledo Refinery's capacity, which was not included in that report, was both added to the US capacity and counted as the Toledo Refinery's capacity. See Attachment 3 of Appendix A1.1. For hydrogen capacity, the capacity of the Linde hydrogen plant which is tied into the Toledo Refinery's flare system was added to both the U.S. capacity reported in the US EIA Report "U.S. Number and Capacity of Petroleum Refineries" (published 6/25/2018), and included in the Toledo Refinery's hydrogen capacity.

[2] O&GJ (12/1/2014) = Oil & Gas Journal Worldwide Refining Survey (published 12/1/2014) of petroleum refinery capacities as of 1/1/2015, published 12/1/2014).
"Worldwide Refineries – Capacities as of 1/1/2015". U.S. data on p. 3. See Attachment 3 of Appendix A1.1.
"Worldwide Refining". PBF Holding Co - Toledo Refinery data on p. 54. See also Attachment 1 of this Appendix A1.2

[3] Part 5, 6, or 7, Toledo Refinery 2018 EIA-820 = U.S. Energy Information Administration Form EIA-820 submitted by the Toledo Refinery. See Attachment 2 of Appendix A1.1.

[4] Process not at Toledo Refinery in 2018

[5] EIA Website 2018 Data – No. and Cap. = U.S. Energy Information Administration Website (www.eia.gov), "Number and Capacity of Petroleum Refineries" for the Year 2018. See Attachment 1 of Appendix A1.1

[6] EIA Website 2018 Data – Prod. Cap. = U.S. Energy Information Administration "Production Capacity of Operable Petroleum Refineries" for the year 2018. See Attachment 1 of Appendix A1.1

APPENDIX A1.2

ATTACHMENT 1

WORLDWIDE REFINING Company and refinery location	Charge capacity, b/cd								Production capacity, b/cd									
	Crude	Vacuum distillation	Coking	Thermal operations	Catalytic cracking	Catalytic reforming	Catalytic hydrocracking	Catalytic hydrotreating	Alkylation	Pol./Dim.	Aromatics	Isomerization	Lubes	Oxygenates	Hydrogen (MMcfd)	Coke (t/d)	Sulfur (t/d)	Asphalt
PBF Holding Co. LLC—Toledo	170,000	30,000	—	—	[1]60,000	[1]45,600	[1]28,200	[1]48,000	[1]9,000	—	[1]9,000	—	—	—	[1]52.0	—	—	—
Total	**572,000**	**180,625**	**52,200**	**—**	**170,200**	**153,300**	**79,500**	**322,250**	**26,450**	**—**	**15,300**	**16,200**	**—**	**—**	**62.4**	**2,806**	**540**	**23,100**
OKLAHOMA																		
Phillips 66—Ponca City	203,000	80,000	[2]23,100	—	[1]59,300	[1]44,000	—	[1]44,000 [4]14,850 [5]54,100 [8]19,800 [12]43,700 [13]12,100	[2]13,000	[1]2,400	—	[1]10,000 [3]13,400	—	—	[1]31.4 [6]15.4	1,150	200	—
Holly Frontier Corp.—Tulsa	125,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Valero Energy Corp.—Ardmore	90,000	32,000	—	—	[1]30,576	[3]21,679	[1]12,000	[1]26,500 [5]28,000 [8]32,000	[2]7,012	—	—	[3]7,000	—	—	[1]26.0 [4]26.0	—	243	11,000
Wynnewood Refining Co.—Wynnewood	70,000	42,000	—	—	[1]20,500	[3]18,500	[1]15,000	[1]12,500 [5]4,400 [12]13,000	[2]4,000	—	—	[3]3,500	—	—	[1]9.0	—	—	5,000
Total	**488,000**	**154,000**	**23,100**	**—**	**110,376**	**84,179**	**27,000**	**304,950**	**24,012**	**2,400**	**—**	**33,900**	**—**	**—**	**107.8**	**1,150**	**443**	**16,000**
PENNSYLVANIA																		
American Refining Group—Bradford	11,000	—	—	—	—	[1]1,800	—	[1]3,500	—	—	—	[3]600	2,600	—	—	—	—	—
Delta Air Lines—Trainer	185,000	78,700	—	—	[1]48,400	[3]48,800	[c 4]21,500	[1]51,900 [5]25,800 [8]38,300 [12]14,200	[2]11,800	—	—	—	—	—	—	—	160	—
Philadelphia Energy Solutions—Philadelphia	330,000	157,400	—	—	[1]113,500	[1]68,000	—	[1]85,600 [5]78,000	[2]16,700	—	[1]3,700 [4]10,000	[1]7,300	—	—	—	—	—	—
United Refining Co.—Warren	70,000	27,000	—	—	[1]23,000	[2]16,000	—	[2]20,000 6,000 [7]14,000	[1]3,500	[1]1,000	—	[3]6,800	—	—	—	—	—	12,000
Total	**596,000**	**263,100**	**—**	**—**	**184,900**	**134,600**	**21,500**	**337,300**	**32,000**	**1,000**	**13,700**	**14,700**	**2,600**	**—**	**—**	**—**	**160**	**12,000**
TENNESSEE																		
Valero Energy Corp.—Memphis	195,000	—	—	—	[1]69,000	[3]36,000	—	[1]52,000 [5]73,600 [12]25,715	[2]12,000	—	—	[3]4,000	—	—	—	748	105	—
Total	**195,000**	**—**	**—**	**—**	**69,000**	**36,000**	**—**	**151,315**	**12,000**	**—**	**—**	**4,000**	**—**	**—**	**—**	**748**	**105**	**—**
TEXAS																		
Alon USA—Big Spring	73,000	24,000	—	—	[1]24,000	[1]21,000	—	[1]25,500	[2]5,000	—	[1]2,000	—	—	—	—	—	135	8,000

APPENDIX A1.3

APPENDIX A1.3

CALCULATING THE AMOUNT OF STIPULATED PENALTIES DUE FOR VIOLATING LIMITATIONS ON FLARING WHEN THE STIPULATED PENALTIES ARE BASED ON EXCESS VOCs AND SO_2 EMITTED

I. Stipulated Penalties for Violating the 365-day Rolling Average Limit. The following equation shall be used to calculate the amount of stipulated penalties due for violating the 365-day rolling average limit on flaring:

$$\text{Penalty due} = \sum_{i=1}^{n} [\$\$_{365d,VOC} \times EE_{365d,VOC}] + [\$\$_{365d,SO2} \times EE_{365d,SO2}] \quad \textbf{(Eq. 1)}$$

Where:

n	=	Each day the 365-day rolling average limit is exceeded
$\$\$_{365d,VOC}$	=	Dollars per ton of VOC for violating 365-day limit ($80/ton because the Toledo Refinery is in an ozone attainment area)
$EE_{365d,VOC}$	=	365-day average VOC emissions above the flow limit on day limit is violated; *see* Equation 2
$\$\$_{365d,SO2}$	=	Dollars per ton of SO_2 for violating 365 day cap ($40/ton)
$EE_{365d,SO2}$	=	365-day average SO_2 emissions above the flow limit on day limit is violated; *see* Equation 3

II. Calculating Average Emissions of VOCs Above the Flow Limit When Violating the 365-Day Rolling Average Limit. The following equation shall be used to calculate the 365-day average VOC emissions above the flow limit for the day that the 365-day rolling average limit is violated:

$$EE_{365d,VOC} = [Q_{365d,actual} - Q_{365d,allowable}][VOC_{365d,vol\ fraction}]\ [.0026]\ [MW_{365d,VOC}]\ [.0005][1 - CE_{365d,as\ fraction}] \quad \textbf{(Eq. 2)}$$

Where:

$EE_{365d,VOC}$	=	365-day average VOC emissions above the flow limit on the day that the 365-day rolling average limit is violated, in tons per day
$Q_{365d,actual}$	=	Actual 365-day rolling average Waste Gas Flow Rate on the day that the 365-day rolling average limit is violated, in scfd

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$Q_{365d,allowable}$ = Allowable 365-day rolling average Waste Gas Flow Rate taken from the Consent Decree, in scfd

$VOC_{365d,vol\ fraction}$ = 365-day flow weighted rolling average VOC volume fraction in the Waste Gas on the day that the 365-day rolling average limit is violated. [NOTE: This is the VOC fraction in the Waste Gas, not the Flare Vent Gas.] The daily flow weighted average VOC volume fraction shall be determined from an average of the hourly average VOC concentration weighted by waste gas flow. The 365-day flow weighted rolling average VOC volume fraction shall be determined from daily flow weighted CE and daily flow of waste gas.

.0026 = 1 lb-mole VOC/385.5 scf

$MW_{365d,VOC}$ = 365-day flow weighted rolling average Molecular Weight of VOCs on the day that the 365-day rolling average limit is violated, in lb/lb-mole. The daily flow weighted average molecular weight (MW) shall be determined from an average of the hourly average MW weighted by waste gas flow. The 365-day flow weighted rolling average MW shall be determined from daily flow weighted MW and daily flow of waste gas.

.0005 = 1 ton/2000 lb

$CE_{365d,as\ fraction}$ = 365-day rolling average Combustion Efficiency ("CE") determined from the NHV_{cz} of the Combustion Zone Gas as follows:

NHV_{cz} (BTU/scf)	$CE_{as\ fraction}$
$NHV_{cz} < 95$	0.0
$95 <= NHV_{cz} < 300$	$[0.16*(-95+ NHV_{cz})]/[1+0.16*(-95+ NHV_{cz})]$
$300 <= NHV_{cz} < 350$	0.98
$350 <= NHV_{cz} < 425$	0.985
$425 <= NHV_{cz} < 500$	0.9875
$500 <= NHV_{cz} < 600$	0.99
$600 <= NHV_{cz}$	0.995

Combustion Efficiency shall be determined hourly from the hourly average NHV_{cz} using the table above. The daily flow weighted average CE shall be determined from an average of the hourly average CE values weighted by waste gas flow. The 365-day flow weighted rolling average CE shall be determined from daily flow weighted CE and daily flow of waste gas.

APPENDIX A1.3

III. <u>Calculating the Average Emissions of SO_2 Above the Flow Limit when Violating the 365-Day Rolling Average Limit</u>. The following equation shall be used to calculate the 365-day average SO_2 emissions above the flow limit for the day that the 365-day rolling average limit is violated:

$$EE_{365d,SO2} = [Q_{365d,actual} - Q_{365d,allowable}]\,[C_{365d,H2S}/1{,}000{,}000]\,[8.30 \times 10^{-5}] \qquad \textbf{(Eq. 3)}$$

Where:

$EE_{365d,SO2}$	=	365-day average SO_2 emissions above the flow limit on the day that the 365-day rolling average limit is violated, in tons per day
$Q_{365d,actual}$	=	Actual 365-day rolling average Waste Gas Flow Rate on the day that the 365-day rolling average limit is violated, in scfd
$Q_{365d,allowable}$	=	Allowable 365-day rolling average Waste Gas Flow Rate taken from the Consent Decree, in scfd
$C_{365d,H2S}$	=	365-day rolling average concentration of H_2S in Waste Gas on the day that the that the 365-day rolling average limit is violated, in ppmv
8.30×10^{-5}	=	[1 lb-mole H_2S/385.5 scf] [64 lb SO_2/lb-mole H_2S] [Ton/2000 lb]