BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R 23-18(A)
AMENDMENTS TO 35 ILL. ADM. CODE PARTS 201, 202, AND 212	)	(Rulemaking – Air)
	)	

NOTICE OF FILING

TO: Mr. Don A. Brown,
Clerk of the Board
Illinois Pollution Control Board
60 East Van Buren Street,
Suite 630
Chicago, Illinois 60605

Timothy Fox
Chloe Salk
Hearing Officers
Illinois Pollution Control Board
60 East Van Buren Street, Suite 630
Chicago, Illinois 60605

(SEE PERSONS ON ATTACHED SERVICE LIST)

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Illinois Pollution Control Board, **ENTRY OF APPEARANCE on behalf of CITGO PETROLEUM CORPORATION** and **AMERICAN PETROLEUM INSTITUTE AND CITGO'S SUPPLEMENTAL RESPONSE TO ILLINOIS EPA'S COMMENT,** copies of which, are hereby served upon you.

Respectfully submitted,

AMERICAN PETROLEUM INSTITUTE,
CITGO PETROLEUM CORPORATION,

By: **/s/** Alec Messina
One of its Attorneys

Dated: March 15, 2024

Alec Messina
HEPLERBROOM, LLC
4340 Acer Grove Drive
Springfield, Illinois 62711
Alec.Messina@helperbroom.com
(217) 528-3674

CERTIFICATE OF SERVICE

I, the undersigned, on oath state the following: That I have served the attached **APPEARANCE and SUPPLEMENTAL RESPONSE TO ILLINOIS EPA'S COMMENT**, via electronic mail upon:

Mr. Don A. Brown
Clerk of the Board
Illinois Pollution Control Board
60 East Van Buren Street, Suite 630
Chicago, Illinois 60605
don.brown@illinois.gov

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Chloe Salk
Hearing Officers
Illinois Pollution Control Board
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Melissa S. Brown
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Springfield, IL 62711
Melissa.Brown@heplerbroom.com

That my email address is Alec.Messina@heplerbroom.com

That the number of pages in the email transmission is 101.

That the email transmission took place before 5:00 p.m. on March 15, 2024.

Date: March 15, 2024

/s/ Alec Messina
Alec Messina

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
	)	
	)	R 23-18(A)
AMENDMENTS TO 35 ILL. ADM. CODE	)	(Rulemaking – Air)
PARTS 201, 202, AND 212	)	

ENTRY OF APPEARANCE OF ALEC MESSINA

NOW COMES Alec Messina, of the law firm HEPLERBROOM, LLC, and hereby enters his appearance in this matter on behalf of CITGO PETROLEUM CORPORATION.

Respectfully Submitted,

By: /s/ *Alec Messina*

DATE: March 15, 2024

Alec Messina
HEPLERBROOM, LLC
4340 Acer Grove Drive
Springfield, IL 62711
Alec.Messina@heplerbroom.com
(217) 528-3674

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	**)**	
	)	
AMENDMENTS TO 35 ILL. ADM. CODE	**)**	**R 23-18(A)**
PARTS 201, 202, AND 212	**)**	**(Rulemaking – Air)**

THE AMERICAN PETROLEUM INSTITUTE'S AND CITGO'S SUPPLEMENTAL RESPONSE TO ILLINOIS EPA'S COMMENT

The AMERICAN PETROLEUM INSTITUTE ("API") and CITGO PETROLEUM CORPORATION ("CITGO"), by and through its undersigned attorney, pursuant to the March 6, 2024 Notice of Hearing, hereby submits to the Illinois Pollution Control Board ("Board") their Supplemental Response to the Illinois Environmental Protection Agency's ("Illinois EPA" or "Agency") October 23, 2023 Comment.

I. INTRODUCTION

On October 23, 2023, Illinois EPA filed a comment in this sub-docket requesting that the Board solicit additional information from the rulemaking proponents. Illinois EPA's Comments, P.C. #5, R 23-18(A), at 27 (Oct. 23, 2023) (hereinafter "Illinois EPA's Comment"). A Motion for Additional Hearing was filed by the Attorney General's Office, requesting that a third hearing be scheduled in this matter to address any additional information that the rulemaking proponents may submit in response to Illinois EPA's Comment. Motion for Additional Hearing, PCB R 23-18(A) (October 26, 2023). The Board granted the motion on November 16, 2023. API filed its Initial Response to Illinois EPA's Comment on December 1, 2023. API's Initial Response to Illinois EPA's Comment, P.C. #9 (Dec. 1, 2023). API and CITGO hereby incorporate by reference API's Initial Response to Illinois EPA's Comment into this Supplemental Response. The Third Hearing is scheduled for April 15, 2024. This Supplemental Response to Illinois EPA's

Comment is timely submitted pursuant to the March 6, 2024 Notice of Hearing. Notice of Hearing, PCB R 23-18(A) (Mar. 6, 2024).

II. RESPONSES TO ILLINOIS EPA'S DATA REQUESTS

In its Comment, Illinois EPA stated that the emissions impact from API's alternative emission limit ("AEL") Proposal will vary by source because each of the sources are "differently sized, configured and operated." Illinois EPA's Comment at 12. Illinois EPA also stated that modeling to demonstrate that API's Proposal will not result in an air quality impact from the refineries' startup and hot standby events would be necessary to submit any revisions adopted by the Board to the United States Environmental Protection Agency ("USEPA") for approval. *Id*. at 12-13. API addresses Illinois EPA's data requests as to ExxonMobil, CITGO, and Marathon below.

A. EXXONMOBIL

As to ExxonMobil Oil Corporation ("ExxonMobil"), in general, Illinois EPA requested additional information regarding the worst-case carbon monoxide ("CO") emissions that take place during startup or hot standby events, as well as the need for Illinois EPA to further evaluate the modeling previously performed by ExxonMobil. As acknowledged by Illinois EPA, ExxonMobil performed a modeling exercise in 2023 and included a report of the modeling as Exhibit 2 to API's First Post-Hearing Comment. Exhibit 2, API's First Post-Hearing Comment, PCB R 23-18(A) (Oct. 18, 2023). Based on the requests included in Illinois EPA's Comment, as well as a meeting between API and Illinois EPA in December 2023, ExxonMobil updated its initial modeling demonstration. ExxonMobil's updated model inputs and results were then reviewed with Illinois EPA during a subsequent meeting. At this meeting, Illinois EPA characterized ExxonMobil's modeling demonstration as conservative.

Both the initial modeling and updated modeling demonstrate that the startups of the FCCU at ExxonMobil's refinery in Channahon, Illinois have not caused exceedances of the carbon monoxide ("CO") National Ambient Air Quality Standard ("NAAQS"), both the 1-hour and 8-hour standards. Additionally, as demonstrated by the results of the updated modeling, startups since 2017 with FCCU regenerator oxygen monitoring and control to comply with the startup standards in 40 CFR Part 63, Subpart UUU (which are proposed by API as its AEL in Section 216.361) have greatly reduced CO emissions and the ambient impacts. API is hereby submitting on behalf of ExxonMobil a report as to the updated modeling performed, which is attached hereto as Exhibit 1.

B. CITGO

As to CITGO Petroleum Corporation ("CITGO"), in general, Illinois EPA requested additional information regarding the worst-case CO emissions that take place during startup or hot standby events. In response to Illinois EPA's Comment and subsequent discussions with Illinois EPA, CITGO has reviewed emissions from its FCCU startup events to determine maximum hourly CO concentrations and emission rates, which were then used to develop statistical worst-case scenarios for both the 1-hour and 8-hour CO NAAQS. Additionally, atmospheric dispersion modeling of the statistical worst-case scenarios was conducted. The results of the modeling demonstrate that even worst-case CO emissions from the FCCU during startup do not have a significant impact on ambient air quality. CITGO is hereby submitting its narrative response to Illinois EPA's request for additional information, which is attached hereto as Exhibit 2. CITGO is also submitting a report as to the modeling performed, which is attached hereto as Exhibit 3.

C. MARATHON

As to Marathon Petroleum Company LP ("Marathon"), in general, Illinois EPA requested additional information regarding the worst-case CO emissions that take place during startup or hot standby events, as well as additional information in relation to the previously performed monitoring at the Robinson refinery. In response to Illinois EPA's Comment and subsequent discussions with Illinois EPA, Marathon has further analyzed its monitoring data. The monitoring demonstrates that there was no instance over four years of any readings over 15% of the 8-hour CO NAAQS and that the max 1-hour was approximately 5% of CO NAAQS. The results of the monitoring demonstrate that the short increases in CO emissions during FCCU startup events do not result in NAAQS violations nor any measurable increase in ambient CO, and therefore have little to no measurable impact on ambient air quality. API is hereby submitting on behalf of Marathon a FCCU Startup and CO Monitor Data Summary, which is attached hereto as Exhibit 4.

III. API'S PROPOSED AEL LANGUAGE

API hereby proposes to revise its AEL in proposed Section 216.361(d) to include language making the proposed AEL applicable to three of the four refineries in Illinois – ExxonMobil's refinery in Channahon, CITGO's refinery in Lemont, and Marathon's refinery in Robinson. API's AEL Proposal filed in August 2023 discussed the potential for increased CO emissions during FCCU startup and hot standby events at all four refineries. Based on subsequent discussions, it has been determined that an AEL is not needed at this time as to WRB Refining LP's FCCU located at its refinery in Wood River, Illinois.

API proposes to revise new Section 216.361(d) as follows:

d) For the petroleum refinery facilities located in Channahon, Lemont, and Robinson, Illinois, despite subsections (a) through (c), during periods of startup and hot standby, ~~any new or existing~~ petroleum catalytic cracking units must comply either with subsections (a) through (c) or the alternate non-numerical

> limitation for these operating modes in 40 CFR 63 Subpart UUU Tables 9, 10, 14, and 41 and 40 CFR 63.1565(a)(5), 40 CFR 63.1570(c) and (f), 40 CFR 63.1572(c) and 40 CFR 63.1576(a)(2) and (d), incorporated by reference in Section 216.104.

In addition to adding the language at the beginning of the provision limiting the applicability of the AEL, API also proposes to remove the language of "any new or existing" in order to make the provision more streamlined. The above language also reflects the non-substantive revisions previously proposed by the Board and JCAR in this proceeding. API requests that the Board adopt API's proposed AEL language in Section 216.361(d) above along with API's proposed revisions to the definitions and incorporations by reference provisions in Sections 216.103 and 216.104.

IV. RECENT D.C. CIRCUIT COURT OF APPEALS' DECISION

Lastly, the Board should be aware of the recently issued decision in *Environmental Committee of the Florida Electric Power Coordinating Group, Inc. v. EPA, et al*. The case was a result of several petitions for review filed as to USEPA's startup, shutdown, and malfunction ("SSM") State Implementation Plan ("SIP") Call. On March 1, 2024, the U.S. Court of Appeals for the District of Columbia ("D.C. Circuit") issued its decision and vacated USEPA's SSM SIP Call with respect to several types of SSM SIP provisions. *Envir. Comm. Fl. Elec. Power Coordinating Group v. EPA*, No. 15-1239, page 68 (D.C. Cir. Mar. 1, 2024). Illinois' SSM provisions, which were repealed by the Board in PCB R 23-18, fell under at least one of these types of SSM provisions as to which the SIP Call was vacated. As such, the basis for the Board's repeal of Illinois' SSM provisions in PCB R 23-18, i.e., USEPA's SIP Call, has been vacated. Nevertheless, API urges the Board to move forward with this sub-docket proceeding and grant the relief requested by API.

V. CONCLUSION

The additional information hereby submitted as to ExxonMobil, CITGO, and Marathon in response to Illinois EPA's Comment demonstrate that FCCU startup and hot standby events do not result in violations of the CO NAAQS or any adverse impacts on air quality. API and CITGO hereby respectfully submit their Supplemental Response to Illinois EPA's Comment and request that the Board adopt API's AEL Proposal.

Respectfully submitted,

AMERICAN PETROLEUM INSTITUTE
and CITGO PETROLEUM CORP.,

Dated: March 15, 2024

By: /s/ Alec Messina
One of Their Attorneys

Alec Messina
HEPLERBROOM, LLC
4340 Acer Grove Drive
Springfield, Illinois 62711
Alec.Messina@heplerbroom.com
(217) 528-3674

EXHIBIT 1

MEMORANDUM

To: **Brad Sims and Terry Cirbo, ExxonMobil Oil Corporation**

From: **Jim Donaldson and Reshawn George, Trinity Consultants, Inc.**

Date: **March 7, 2024**

RE: **Carbon Monoxide Dispersion Modeling for the FCC Unit**

Trinity Consultants, Inc. (Trinity) performed a revised dispersion modeling analysis for emissions of carbon monoxide (CO) from the fluidized catalytic cracking unit (FCC Unit) at the ExxonMobil Oil Corporation (ExxonMobil) refinery near Joliet, Illinois (Joliet facility) to determine conservatively the ground level concentrations of CO at various emission rates during startup conditions for comparison to the national ambient air quality standards (NAAQS). The revised dispersion model inputs were provided by ExxonMobil in response to Illinois Environmental Protection Agency's (Agency) written comments and subsequent Agency discussions. As described below, based on original and revised model results, emissions during startup operations of ExxonMobil's FCC Unit do not cause an exceedance of the CO NAAQS.

The following methodology and conditions were used in the dispersion model:

The current U.S. EPA regulatory model, AERMOD (version 23132) was used, as incorporated within Trinity's *BREEZE™ AERMOD Pro* software, in conjunction with the following guidance documents:

- U.S. EPA's *Guideline on Air Quality Models* 40 CFR 51, Appendix W (Revised, January 17, 2017);
- U.S. EPA's *AERMOD Implementation Guide* (Revised August 2019); and
- U.S. EPA's *New Source Review Workshop Manual* (Draft, October 1990);

The Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) (version 04274) was used to determine the building downwash characteristics for each stack;
In all modeling input and output files, the locations of the emission source, structures, and receptors were represented in the Universal Transverse Mercator (UTM) coordinate system in UTM Zone 16;
All model objects were defined in the North American Datum of 1983 (NAD83);
Trinity used a variable-density, circular Cartesian receptor grid to determine the extent of the significant impact area (SIA):

- Property line receptors with a spacing of 50 meters
- 100-meter spacing, extending from the property line to approximately 4,000 meters from the facility center
- 500-meter spacing, from 4,000 meters to approximately 6,500 meters from the facility center
- 1,000-meter spacing, from 6,500 meters to approximately 15,000 meters from the facility center
- 2,500-meter spacing, from 15,000 meters to approximately 50,000 meters from the facility center
- The terrain elevation for each receptor point, emission source, and structure was determined using the AERMOD terrain processor, AERMAP (version 18081);

The meteorological data used for this modeling demonstration were obtained from the Midway International Airport, located in Chicago, Illinois.

- Met data were pre-processed for AERMOD using AERMET (version 23132) for the years 2018 through 2022.
- One-minute wind data were processed using the AERMINUTE program (version 15272) and input to AERMET (version 23132)

EXHIBIT 1

MEMORANDUM

- The regulatory default ADJ_U* option was selected in AERMET

The FCC Unit was modeled at two sets of conditions. The first model run ("4,900 lb/hr") is a repeat of the model run addressed in the October 13, 2023 Trinity memorandum using the updated meteorological data set provided by the Agency as a follow-up to the above-mentioned discussions (replacing met data for the years 2012-2016 with years 2018-2022). As the Agency wanted ExxonMobil to look back to at least two historical startups involving refractory repair, ExxonMobil expanded the lookback beyond 2017 to 2013. The second model run ("35,200 lb/hr"), represents the highest single hour emission rate which occurred during the June 7, 2013 startup, with modeling based on measurements made with its regulatory continuous emission monitoring system (CEMS) and FCC stack temperature and flow measurements during the event. For purposes of modeling the longer eight-hour (8-hr) averaging period, it was conservatively assumed that the conditions of the highest single hour were sustained over the eight hours.

The stack dimensions are a height of 250 feet and diameter of 14 feet. For the first model run (repeat), the average stack temperature was 141 °F, stack concentration was 2,000 ppm and maximum flow rate was 69 feet per second, resulting in a CO emission rate of 4,902 pounds per hour. For the second model run, the average stack temperature was 157 °F, stack concentration was 43,800 ppm, and maximum flow rate was 137 feet per second, resulting in a CO emission rate of 35,200 pounds per hour.

The maximum modeled ground level impacts for CO under these conditions are shown in the table below:

CO Modeled Emission Rate	Averaging Period	Maximum impact (ppm)*	NAAQS (ppm)	Percent of NAAQS	Max Receptor UTM Easting (m)	Max Receptor UTM Northing (m)
4,900 lb/hr	1-hr	0.97	35	2.77%	402100	4585200
	8-hr	0.47	9	5.18%	401300	4586400
35,200 lb/hr	1-hr	4.73	35	13.51%	402500	4585000
	8-hr	1.78	9	19.75%	401200	4586200

*Summary model results attached. AERMOD outputs are in terms of µg/m^3, aproximately 1,165 × the value of CO in terms of ppm

Based on these modeled results coupled with Illinois EPA ambient monitor data (https://epa.illinois.gov/topics/air-quality/outdoor-air/air-monitoring/air-quality-reports.html), operation of the FCC during startup conditions is not expected to cause an exceedance of the CO NAAQS.

Figure 1 – Summary of Highest 1-Hour Results at 4,900 Lb/Hr Emission Rate

MEMORANDUM

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                          *** THE SUMMARY OF HIGHEST  1-HR RESULTS ***

                   ** CONC OF CO       IN MICROGRAMS/M**3                         **

                                                   DATE                                                         NETWORK
GROUP ID                          AVERAGE CONC     (YYMMDDHH)           RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)   OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS    1128.88178  ON 21010611: AT (  402100.00,  4585200.00,   161.69,   161.69,   0.00)  DC

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
♀ *** AERMOD - VERSION 23132  ***   ***  ExxonMobil - Joliet, Illinois                                ***       03/06/24
 *** AERMET - VERSION  23132 ***   ***  CO Modeling - Year 2018-2022                                 ***       11:41:23
                                                                                                              PAGE 179
 *** MODELOPTs:     RegDFAULT  CONC  ELEV  NODRYDPLT  NOWETDPLT  RURAL  ADJ_U*

 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of           0 Fatal Error Message(s)
 A Total of           3 Warning Message(s)
 A Total of         213 Informational Message(s)

 A Total of       43824 Hours Were Processed

 A Total of          75 Calm Hours Identified

 A Total of         138 Missing Hours Identified (  0.31 Percent)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
 ME W186    7188       MEOPEN: THRESH_1MIN 1-min ASOS wind speed threshold used          0.50
 ME W187    7188       MEOPEN: ADJ_U* Option for Stable Low Winds used in AERMET
 OU W565    7194       OUPLOT: Possible Conflict With Dynamically Allocated FUNIT     PLOTFILE

    ************************************
    *** AERMOD Finishes Successfully ***
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MEMORANDUM

Figure 2 – Summary of Highest 8-Hour Results at 4,900 Lb/Hr Emission Rate

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                                ** CONC OF CO       IN MICROGRAMS/M**3                        **

                                                      DATE                                                                  NETWORK
GROUP ID                              AVERAGE CONC     (YYMMDDHH)            RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS     543.61957  ON 21031016: AT (  401300.00,  4586400.00,   163.79,   163.79,    0.00)  DC


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
? *** AERMOD - VERSION 23132  ***   ***  ExxonMobil - Joliet, Illinois                                  ***        03/06/24
 *** AERMET - VERSION  23132 ***   ***  CO Modeling - Year 2018-2022                                   ***        11:56:15
                                                                                                                  PAGE 179
 *** MODELOPTs:    RegDFAULT  CONC  ELEV  NODRYDPLT  NOWETDPLT  RURAL  ADJ_U*

 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            3 Warning Message(s)
 A Total of          213 Informational Message(s)

 A Total of        43824 Hours Were Processed

 A Total of           75 Calm Hours Identified

 A Total of          138 Missing Hours Identified (  0.31 Percent)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
 ME W186    7188       MEOPEN: THRESH_1MIN 1-min ASOS wind speed threshold used          0.50
 ME W187    7188       MEOPEN: ADJ_U* Option for Stable Low Winds used in AERMET
 OU W565    7194       OUPLOT: Possible Conflict With Dynamically Allocated FUNIT     PLOTFILE

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
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MEMORANDUM

Figure 3 – Summary of Highest 1-Hour Results at 35,200 Lb/Hr Emission Rate

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                              *** THE SUMMARY OF HIGHEST  1-HR RESULTS ***

                    ** CONC OF CO        IN MICROGRAMS/M**3                        **

                                                      DATE                                                                 NETWORK
GROUP ID                            AVERAGE CONC     (YYMMDDHH)          RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS    5510.01298  ON 21010611: AT (  402500.00,  4585000.00,    163.63,    163.63,    0.00)  DC

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
? *** AERMOD - VERSION 23132  ***   ***  ExxonMobil - Joliet, Illinois                                   ***        03/06/24
 *** AERMET - VERSION  23132 ***   ***  CO Modeling - Year 2018-2022                                    ***        11:11:04
                                                                                                                   PAGE 179
 *** MODELOPTs:    RegDFAULT  CONC  ELEV  NODRYDPLT  NOWETDPLT  RURAL  ADJ_U*

 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of           0 Fatal Error Message(s)
 A Total of           3 Warning Message(s)
 A Total of         213 Informational Message(s)

 A Total of       43824 Hours Were Processed

 A Total of          75 Calm Hours Identified

 A Total of         138 Missing Hours Identified (  0.31 Percent)

    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***

    ********   WARNING MESSAGES   ********
 ME W186    7188       MEOPEN: THRESH_1MIN 1-min ASOS wind speed threshold used          0.50
 ME W187    7188       MEOPEN: ADJ_U* Option for Stable Low Winds used in AERMET
 OU W565    7194       OUPLOT: Possible Conflict With Dynamically Allocated FUNIT     PLOTFILE

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
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MEMORANDUM

Figure 4 – Summary of Highest 8-Hour Results at 35,200 Lb/Hr Emission Rate

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                                              *** THE SUMMARY OF HIGHEST  8-HR RESULTS ***

                                  ** CONC OF CO       IN MICROGRAMS/M**3                             **

                                                      DATE                                                                NETWORK
GROUP ID                         AVERAGE CONC     (YYMMDDHH)          RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS    2070.94285  ON 22061916: AT (  401200.00,  4586200.00,    164.28,    164.28,     0.00)  DC

 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
♀ *** AERMOD - VERSION 23132  ***   ***  ExxonMobil - Joliet, Illinois                                 ***        03/06/24
 *** AERMET - VERSION  23132 ***   ***  CO Modeling - Year 2018-2022                                    ***        11:27:02
                                                                                                                   PAGE 179
 *** MODELOPTs:    RegDFAULT  CONC  ELEV  NODRYDPLT  NOWETDPLT  RURAL  ADJ_U*

 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of           0 Fatal Error Message(s)
 A Total of           3 Warning Message(s)
 A Total of         213 Informational Message(s)

 A Total of       43824 Hours Were Processed

 A Total of          75 Calm Hours Identified

 A Total of         138 Missing Hours Identified (  0.31 Percent)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
 ME W186    7188       MEOPEN: THRESH_1MIN 1-min ASOS wind speed threshold used          0.50
 ME W187    7188       MEOPEN: ADJ_U* Option for Stable Low Winds used in AERMET
 OU W565    7194       OUPLOT: Possible Conflict With Dynamically Allocated FUNIT     PLOTFILE

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

EXHIBIT 2

CITGO PETROLEUM CORPORATION

LEMONT REFINERY

FACILITY ID NO. 197090AAI

CAAPP APPLICATION NO. 96030079

RESPONSE TO IEPA COMMENT TO IPCB, REGARDING FCCU INFORMATION

FEBRUARY 2024

EXHIBIT 2

CITGO Petroleum Corporation Lemont Refinery Response to IEPA Comment to IPCB, Regarding FCCU Information

Introduction

Illinois Environmental Protection Agency (IEPA) commented to the Illinois Pollution Control Board (IPCB) in the matter of Case R2023-018(A) on October 23, 2023, responding to various entities' proposals for rule amendments to better address certain startup, shutdown, malfunction (SSM) provisions.[1] One of the entities, American Petroleum Institute (API), proposed rules addressing SSM provisions for Carbon Monoxide (CO) from Fluid Catalytic Cracking Units (FCCUs) by including alternate emission limits (AELs)[2], consistent with what U.S. EPA has already formalized in their requirements for 40 CFR 63 Subpart UUU for FCCUs[3].

IEPA, in their comments regarding API's proposal for FCCU CO AELs during startup, requested certain refinery-specific information be provided to the IPCB. This document responds to those requests.

Emissions from FCCU startup events were reviewed to determine maximum hourly CO concentrations and emission rates. These maxima were further reviewed to develop statistical worst-case scenarios, for both 1-hr and 8-hr averages (averaging periods of relevant air quality parameters).

In addition to responding to IEPA's refinery specific requests, atmospheric dispersion modeling of the statistical worst-case scenarios was conducted. The dispersion modeling results indicate that the statistical worst-case scenario CO emissions do not have a significant impact on ambient air quality. The modeled statistical worst case scenario CO emissions:

- Are well below the Significant Impact Level (SIL). The increased concentrations are 12-18% of the SIL, depending on averaging period.
- Do not significantly impact the National Ambient Air Quality Standards (NAAQS) for ambient CO concentration. Ambient CO only increases by 0.56% to 0.75% of the applicable CO NAAQS, depending on averaging period. And
- Ambient CO remains < 7% or 1% of the applicable CO NAAQS, depending on the averaging period.

This response document has three sections.

- The "Background" section provides an overview of the Lemont Refinery FCCU and various modes of operation.
- The "Response to IEPA Comments" section provides detailed responses to IEPA's specific comments.
- The "Dispersion Modeling Results" section provides an overview of dispersion modeling of CO for several startup scenarios.

[1] Illinois Environmental Protection Agency's Comments P.C. #5 (IPCB Doc. 109202)
[2] Proposal for Regulations of General Applicability on behalf of American Petroleum Institute (IPCB Doc. 108731)
[3] U.S. EPA - 40 CFR 63.1565(a)(5)

The document also contains three Appendices.

- Appendix A contains various data tables summarizing emissions for various non-normal operating modes:
    - Startup with refractory dryout
    - Hot standby not associated with startup
    - Startup without refractory dryout
    - CO Boiler trips/shutdowns
- Appendix B contains tables showing how statistical worst-case stack parameters were determined for 1-hr average dispersion modeling and 8-hr average dispersion modeling.
- Appendix C contains the third-party consultant's dispersion modeling report.

I. Background

To put these responses in context, background information regarding the Lemont Refinery FCCU is warranted. The Lemont Refinery FCCU was designed to operate as a partial burn FCCU (that is, no excess oxygen (O_2) from the regenerator), and as such has a CO Boiler. The FCCU can be (and has been since August 2015) operated as a full-burn unit (that is, excess O_2 in the flue gas leaving the regenerator). The CO boiler is followed by a Selective Catalytic Reduction (SCR) system for Nitrogen Oxides (NO_X) control and a Wet Gas Scrubber/Wet Electrostatic Precipitator (WGS/WESP) system for Particulate Matter (PM) and Sulfur Dioxide (SO_2) control. The configuration of the Lemont Refinery FCCU is shown in Figure 1.

There are three nominal types of operation:

- "Normal," where fresh feed (gas oil) is processed to crack the long-chain hydrocarbon feed to shorter chains to produce various higher value products (*e.g.*, gasoline blend stocks).
- "Hot Standby," where the unit is operating on Torch Oil to keep the unit warm while Fresh Feed is not being processed. And,
- "Startups," following a shutdown for either a planned maintenance event or a malfunction.

These are discussed further below:

Normal Operation

Normal operation is when the unit is processing fresh feed (Gas Oil), and the regenerator is combusting coke at nominally stable rates. The Gas Oil is a long chain hydrocarbon and travels up the riser along with catalyst to the reactor, where the long-chain hydrocarbon reacts with the catalyst and is cracked into shorter, more valuable hydrocarbon chains; as part of the reaction, carbon lays down on the catalyst. The hydrocarbon is separated from the catalyst in the reactor by internal cyclones. From the reactor, the hydrocarbon travels to the fractionator where separation occurs, and the coke-laden catalyst flows to the regenerator, where the catalyst coke is combusted internally. The cleaned catalyst flows to the base of the riser, where the sequence begins anew. This is a continuous process.

Because the Lemont Refinery FCCU is equipped with a CO Boiler, the regenerator coke combustion can occur in either of two modes – Partial Burn or Full Burn. Nominal regenerator flue gas CO, CO_2, and O_2 concentrations for either mode of normal operations are summarized in Table 1 below:

Table 1
Nominal Regenerator Flue Gas Concentrations for Partial and Full Burn Modes

Mode	Nominal[a] Regenerator Flue Gas Concentrations During Normal Operations			Balance (by difference from 100)
	CO (%)	CO_2 (%)	O_2(%)	
Partial Burn	8	12	0	80, predominantly N_2
Full Burn	0	16	2.5	81.5, predominantly N_2

[a] Concentrations will vary, but these are representative of the two normal operating modes.

Generally, if there is more than ~0.5% O_2 (rounds to 1% O_2) in the regenerator flue gas, the regenerator is in Full Burn mode. The Lemont Refinery FCCU typically operates in full-burn mode utilizing the CO Boiler to recover latent heat in flue gas and combust CO in the event the full-burn drifts towards partial burn.

Finally, in Normal Operation, the Lemont Refinery FCCU can be operated without using the CO Boiler for a period of time.[4] When operated without the CO Boiler, the FCCU operates in full-burn mode; this type of operation is utilized typically when the CO Boiler comes out of service for maintenance or repair.

Startup

During startups following a unit shutdown (either for planned maintenance or due to a unit malfunction), the diverter valve is opened, diverting regenerator flue gas around the CO Boiler and SCR. This is to prevent the potential for uncombusted hydrocarbon making its way to the CO Boiler firebox and creating a potential for explosion. Note the SCR is bypassed because the flue gas is outside the desired operational temperature of the SCR and would damage the catalyst if it were not bypassed. First, air to the regenerator is heated using the gas-fired air heater (used only during startups). Then Torch Oil (Light Cycle Oil) is introduced to the regenerator, to start getting the regenerator up to temperature before introducing fresh feed (*i.e.*, Startup includes a period of "Hot Standby," which is discussed separately). During this period, there is excess air in the regenerator (*i.e.*, full burn), but while the temperature is increasing, the ability to fully combust Coke/Torch Oil is limited by the temperature within the regenerator. Once the regenerator is approaching an elevated temperature (and typically shortly before introducing fresh feed to the unit), the regenerator flue gas is diverted back to the CO Boiler and SCR.

Hot Standby

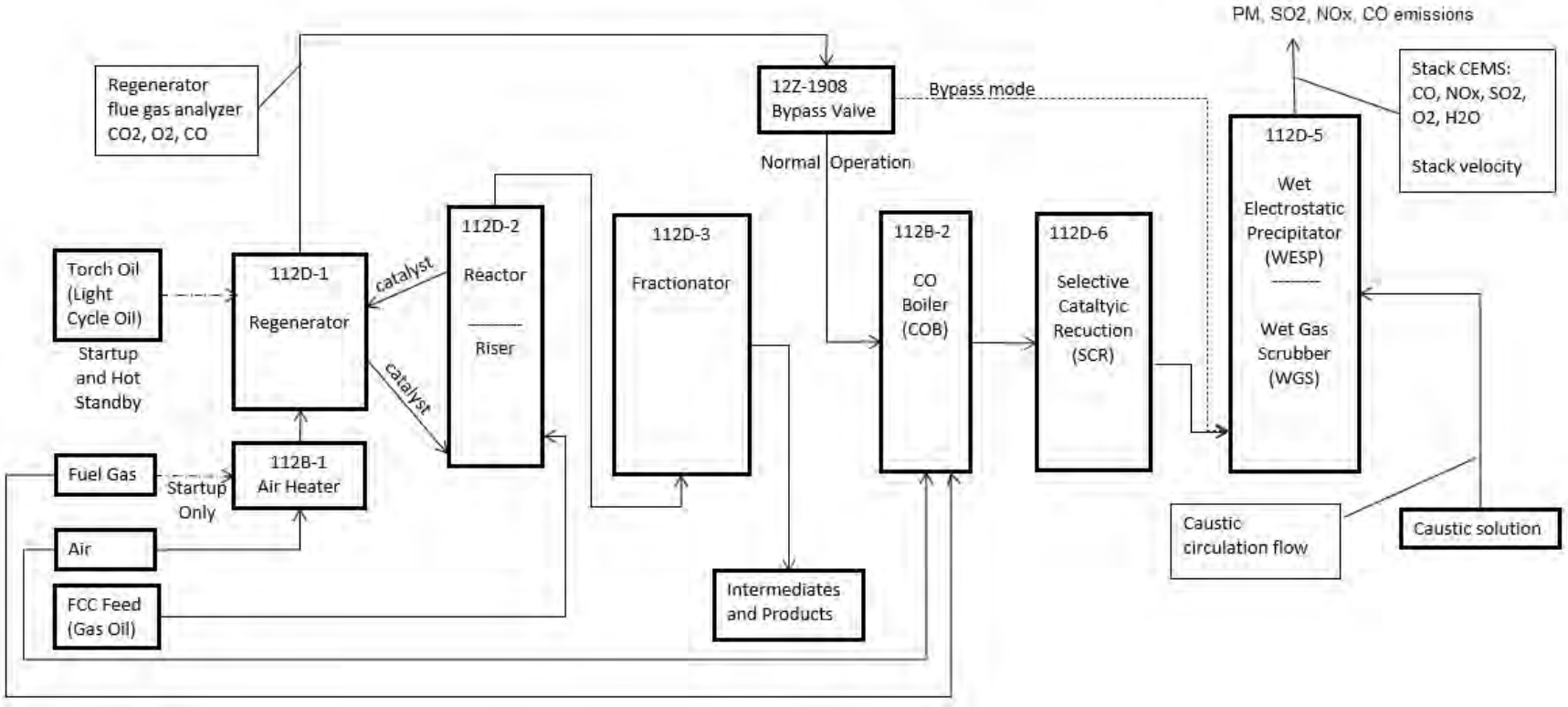
U.S. EPA defines Hot Standby to mean "… periods when the catalytic cracking unit is not receiving fresh or recycled feed oil but the catalytic cracking unit is maintained at elevated temperatures, typically using torch oil in the catalyst regenerator and recirculating catalyst, to prevent a complete shutdown and cold restart of the catalytic cracking unit."[5]

This type of operation can occur when other upstream or downstream units are unable to provide feed to or receive product from the FCCU. In such circumstances, the unit must be either shut down, necessitating a cold restart, or be put on Torch Oil. This type of operation can be conducted either when refinery-wide conditions necessitate, or as an initial element of startup after a unit shutdown (as noted above). When transitioning to torch oil, the regenerator flue gas is typically diverted away from the CO Boiler, to prevent the possibility of hydrocarbon inadvertently entering the CO Boiler firebox. The diversion to the CO Boiler is resumed when the regenerator temperature is at a sufficient temperature.

[4] See Construction Permit 15020015, Condition 2.3
[5] 40 CFR 63.1579

And as noted above, this type of operation is also a part of the startup process, occurring to help get the regenerator up to temperature before introducing fresh feed.

Figure 1
Simplified Lemont Refinery FCCU PFD



II. Response to IEPA Comments

CITGO's responses to IEPA's specific comments are below (IEPA comments are in **bold)**.

1. ***The worst-case CO emissions scenario (in terms of maximum quantity and duration of CO emissions) that takes place during startup or hot standby events, based on the CEMS data and analysis requested below:***

    a. ***The date and duration of the last two startups involving refractory repair, along with CEMS data that provides hourly ppm CO concentration throughout the startup, and calculations of pounds per hour lb/hr CO emissions for each hour of the startup and total CO emissions tonnage from the entire duration of the startup.***

    This should also include the calculation methodology used and include the data inputs (exhaust gas flow rate, oxygen concentration, etc.) used to convert each hourly ppm CO concentration data point to a lb/hr emissions rate for the hour.

    FCCU refractory repair is typically conducted during major maintenance outages at FCCUs. The two most recent startups that involved refractory repair at the Lemont Refinery FCCU were following the 2015 and 2020 Maintenance Turnarounds at the FCCU. These are summarized in Table 2, below.

Table 2
Overview of Excess CO during Maintenance Turnarounds with Refractory Dryout

FCCU Startup Event involving refractory repair	Start Date/time	End Date/Time	No. hrs. in excess of 200 ppmv at 50% EA	No. hrs. in excess of 750 ppmv at 50% EA	Total CO for Startup (lbs.	Mass of CO in Excess of 200 ppmv (lbs.)
Following 2015 Turnaround	7/21/2015 13:25	7/25/2015 15:00	2	1	999.3	519.9
Following 2020 Turnaround	7/13/2020 09:37	7/17/2020 19:59	1	0	1,043.4	314.8

Data Tables A1-1 and A1-2 provide, respectively, for each of the above startup events, the following information:

- Hourly monitored data
    - *in situ* CO (ppmv, wet)
    - *in situ* O2 (% vol, wet)
    - *in situ* H2O (% vol)
    - Stack velocity
    - Stack temperature

  - Regenerator flue gas %O2 (% vol, wet, for reference)
  - Regenerator temperature (°F, for reference)
- Hourly calculated concentration data
  - CO (ppmv, d)
  - O2 (ppmv, d)
  - CO (ppmv, d corrected to 0% O2)
  - CO (ppmv, d corrected to 50% Excess Air (EA))
- Hourly calculated emission rate
- Total emissions during startup

The calculation methodology for mass emission rate is straightforward:

- Calculate a wet actual volume rate of CO
- Convert the actual rate to standard conditions (T = 68 F).
- Convert the scfh to lb.-mol/hr.
- Convert the lb.-mol/hr. to lb. CO/hr.

$$CO\ \left(\frac{lb}{hr}\right) = [CO]_{ppmv,wet} \times V \times 3600 \times \left(\pi\left(\frac{D}{2}\right)^2\right) \times \left(\frac{(459.67+68)}{(459.67+T)}\right) \times \left(\frac{1\ lb-mol}{385.3\ scf}\right) \times \frac{28.0101\ lb}{lb-mol}$$

Where:

Variable	*Definition*
$[CO]_{ppmv,\ wet}$	*In situ* stack concentration of CO (ppmv, wet, uncorrected)
V	Stack velocity, ft/s (wet, actual)
3600	Seconds/hour
π	3.14159
D	Stack diameter, 14 ft.
459.67	Conversion from °F to °Rankine
68	Standard temperature (per 40 CFR 60.2)
T	Stack temperature, °F
385.3	Molar volume conversions (scf/lb.-mol) at standard conditions (68 °F)
28.0101	CO molecular weight, per NIST

b. An analysis of worst-case CO emissions from malfunction and breakdown events, including hot standby, FCCU Regenerator breakdown (including "Behind in Burning" scenarios), and CO Boiler trips.

This analysis should demonstrate whether or not the worst-case CO emissions scenario occurs during startups involving refractory repair or during other scenarios.

<u>Hot Standby Event (not associated with Startups)</u>
Going back to 2015, there is only one instance of the unit being put on "Hot Standby" not associated with a startup following a shutdown (that event occurred recently -- November 7-14, 2023). Table 3 below summarizes that event (indicating no excess CO

during the event). Data Table A2 in Appendix A shows the hourly data associated with that event.

Table 3						
Overview of Excess CO during Hot Standby Events Not Associated with Startup Events						
Hot Standby Events Not Associated with FCCU Startup	*Start Date/time*	*End Date/Time*	*No. hrs. in excess of 200 ppmv at 50% EA*	*No. hrs. in excess of 750 ppmv at 50% EA*	*Total CO for Startup (lbs.*	*Mass of CO in Excess of 200 ppmv (lbs.)*
November 2023	11/7/2023 08:02	11/14/2023 10:14	0	0	0	0

FCCU startups associated with malfunction breakdown events (and not associated with refractory dry-out)

Data Table A3 shows a summary of the four non-refractory-dry-out startups during that period. Of these, the case with the highest mass emission rate and $[CO]_{d, @ 50\% EA}$ occurred during a restart not associated with refractory repair (startup beginning 10/14/2016 00:37). These startups generally include a period of "Hot Standby."

"Behind in Burning"

"Behind in Burning" is not a phrase utilized at the Lemont Refinery. "Behind in Burning," sometimes also referred to as "Afterburning," is the term for the condition that occurs when coke is produced at a faster rate than it can be burned off the catalyst. Effectively this is an inadvertent transition from full-burn to partial burn.

"Behind in Burning" scenarios are not truly malfunctions or "regenerator breakdowns" that result in unit shutdown. This condition is better characterized as a process upset that impacts catalyst activity and decreases yields of gasoline and LPG and increases yield of slurry oil. When this occurs, the condition can be addressed through gradual operational adjustments (air rate, regenerator temperatures, feed rate, etc.).

As noted earlier, the Lemont FCCU operates normally in full burn and utilizes the CO Boiler. But the Lemont FCCU regenerator and CO Boiler were originally designed for partial burn operation and can handle this inadvertent transition. Accordingly, this condition is not expected to result in excess CO.

CO Boiler trips/shutdowns

Data Table A4 shows a summary of operation during CO Boiler trips from 2015 through the present which were not associated with planned FCCU maintenance (*i.e.*, not related to the 2015 or 2020 Turnarounds).

None of the 6 CO Boiler trips noted above showed excess emissions. This is because the FCCU was already operating in full-burn mode each time the CO was tripped off-line. The facility has existing operating procedures in place to operate without the CO Boiler.

Observed maximum hourly CO emission rates and concentrations for the four cases (startup with refractory dry-out, startup without refractory dry-out, hot standby not part of startup, and CO Boiler trips) are shown in Table 4 below with the maximum case bolded:

Table 4

Summary of Maximum CO Emissions for Four Non-Normal Modes of FCCU Operation

Case	*Event Start Date/Time w/ Maximum*	*Max CO (lbs./hr.)*	*Max [CO] @ 50% EA (ppmvd, c)*
Refractory Dry-out (*i.e.*, post TA Hot Standby/startup)	7/21/2015 13:25	412.1	817.5
Non-refractory Dry-out (*i.e.*, Hot Standby/Startup following unplanned unit shutdown)	**10/14/2016 00:37**	**827.4**	**1,203.8**
Hot Standby (not associated with startup)	11/7/2023	0	0
CO Boiler trips (*i.e.*, Operate FCCU in full burn without CO Boiler)	5/11/2019 07:10	102.9	155.2

Bold = Maximum Emission rate and concentration case

This table clearly shows that the Non-Refractory Dry-out case (*i.e.*, the non-Turnaround case) had the maximum hourly emission rate and CO concentration.

2. ***A description of CITGO's FCCU operation with respect to the definitions of "full burn unit" and "partial burn unit" provided on page 15 of the TSD submitted as part of API's Proposal for Regulations of General Applicability, which describes the scenarios in which the FCCU operates in each mode and the following information:***

    a. ***Whether CITGO considers the 1% oxygen waste stream concentration requirement under 40 CFR § 63.1565(a)(5)(ii) to be synonymous with the definition of "full burn unit" provided on page 15 of the TSD.***

    The TSD submitted as part of API's proposal for Regulations of General Applicability included explanations of partial burn units and full burn units.
    - "Partial burn units complete the combustion of the fuel gas (including CO) downstream in a CO Boiler."
    - "A full burn unit (referred to in Section 216.361(b) as "catalyst regenerators for fluidized catalytic converters equipped for in situ combustion of carbon monoxide") operates with excess oxygen to ensure complete combustion and has CO levels of

about 10-100 ppm out of the regenerator during normal operation. Full burn units are generally not equipped with CO boilers.

CITGO's Lemont Refinery FCCU was originally designed for partial burn operation and has a CO Boiler. Beginning in 2015, the Lemont Refinery FCCU has been operated normally in a full-burn mode and continues to utilize its CO boiler (recover latent heat of the flue gas).

As noted above, 1% O2 in the regenerator flue gas is synonymous with full burn. Generally, during normal operations, at this concentration there is very low, if any CO in the regenerator flue gas.

During startup and when firing torch oil to warm up the regenerator, the combustion T in the regenerator is not at the temperature above which CO auto-ignites (1028 °F), and even though there is more than enough air to oxidize CO, the temperature is still too low to support full combustion. Furthermore, it is not desirable at this point to divert to the CO Boiler due to the potential for hydrocarbon pass-through and an unsafe condition in the boiler.

b. If the FCCU typically starts up in full burn mode (Proposal at 31), information as to why it is unable to comply with 500 ppm during startup and hot standby if the definition of "full burn unit" provided on page 15 of the TSD cites CO emission concentrations of 10-100 ppm.

Also, a description of any operating scenarios in which the FCCU starts up in what is considered by CITGO to be a version of "full-burn mode" that differs from the version associated with routine operation and involving CO concentrations of 10-100 ppm.

The definition provided in the Technical Support Document was reflective of normal operations. During startup operations, Lemont Refinery FCCU's excess CO generally occurs when the unit is on Torch Oil, the regenerator is not fully up to temperature, and the diverter valve is being closed (*i.e.*, redirecting regenerator flue gas back to the CO Boiler).

The cooler regenerator flue gas being partially introduced into the CO Boiler creates instability in the gas flows in the boiler's firebox, temporarily degrading the boiler's performance until such time as the interior gas flow patterns restabilize.

c. If CITGO considers a "full burn unit" as defined on page 15 of the TSD to correspond to the language "any existing petroleum or petrochemical process using catalyst regenerators for fluidized catalytic converters equipped for in situ combustion of

carbon monoxide" within 35 Ill. Adm. Code 216.361(b), and the FCCU typically starts up in full burn mode, an explanation as to why CITGO has never chosen to comply with 35 Ill. Adm. Code 216.361(b), rather than 35 Ill. Adm. Code 216.361(a), during startups and why 35 Ill. Adm. Code 216.361(b) has never been included in the CAAPP Permit provisions applying to the FCCU.

The construction permit for the 2015 Turnaround Scope (15020014) was revised in 2019 to recognize that the unit could be operated in full-burn without the CO Boiler. Part of the language that was added clearly stated that 216.361(b) was applicable.

> When operating Unit 112 in full-burn mode and not using the CO Boiler, Unit 112 is subject to 35 IAC 216.361(b), which provides that, notwithstanding 35 IAC 216.316(a), any existing petroleum or petrochemical process using catalyst regenerators of fluidized catalytic converts equipped for in situ combustion of CO, may emit a CO waste gas stream into the atmosphere if the CO concentration of such waste gas stream is less than or equal to 750 ppm corrected to 50 percent excess air.[6]

Additionally, that construction permit did not go into detail on startups, because that was already addressed in the CAAPP Permit (96030079). The inclusion of 216.361(b) was never included in the CAAPP Permit because the CAAPP Permit had (and still has) startup/shutdown provisions for the FCCU.[7]

Note, that the wording of this condition basically limits the applicability of 35 IAC 216.361(b) to those cases where the CO boiler is down. This condition would not be applicable during startup while the CO boiler is operating but is being bypassed for safety reasons, but ultimately venting out the same stack.

[6] Permit 15020014, Condition 2.3.2.a.
[7] See CAAPP Permit 96030079, condition 7.3.3.1.a.

III. Dispersion Modeling Results

Dispersion modeling of FCCU startup carbon monoxide (CO) emissions was conducted to confirm there was no significant ambient impact. Modeled CO concentrations were compared with U.S. EPA's Significant Impact Levels (SILs) and National Ambient Air Quality Standards (NAAQS) for CO.

As neither CO Boiler trips nor Hot Standby without startup had excess CO emissions, dispersion modeling was conducted by a third-party contractor only for three FCCU startup scenarios. The three scenarios modeled were:

1) A statistical worst-case scenario, using the average + 2 standard deviations for emission rate, and average – 2 standard deviations for velocity and temperature.
2) The maximum actual worst case emission rate scenario, and
3) The minimum velocity and temperature scenarios, with corresponding emission rates.

The statistical boundaries used for Scenario 1 were greater than the observed max for emission rate and less than the observed minimum for temperature and velocity. This ensures the model results are conservative. Scenarios 2 and 3 (maximum emission rate case and minimum temperature/velocity case) were included to confirm the statistical worst-case scenarios was indeed conservative.

Table 5 below summarizes the dispersion modeling inputs.

Appendix B, at Data Tables B1 and B2, provides more granularity and shows the potential 1-hr and 8-hr average modeling parameters for each startup event as well as how the statistical worst case was developed.

Table 5

Summary of Potential Dispersion Modeling Inputs

Case	*H Ht. (m)*	*T Temp., 1-hr avg. (°K)*	*T Temp., 8-hr avg. (°K)*	*V Velocity, 1-hr avg. (m/s)*	*V Velocity, 8-hr avg. (m/s)*	*D Diam. (m)*	*CO Emission Rate, 1-hr avg. (g/s)*	*CO Emission Rate, 8-hr avg. (g/s)*	*Latitude*	*Longitude*
Statistical Worst-Case (SWC) Scenario	60.6552	331.5101	329.7202	6.0864	6.0541	4.2977	101.8432	29.0426	41:38:42.3	88:03:14.73
(Basis)	Actual	Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.	Actual	Avg. + 2 Std. Dev.	Avg. + 2 Std. Dev.	Actual	Actual
Maximum Emission Rate Event	60.6552	334.2117	340.9552	9.8718	13.1758	4.2977	89.6783	28.6020	41:38:42.3	88:03:14.73
Min., Velocity Event	60.6552	333.1145	332.8317	6.5699	7.9805	4.2977	34.7394	10.4908	41:38:42.3	88:03:14.73
Dispersion Modeling Inputs										
Scenario 1 SWC	60.6552	331.5101	329.7202	6.0864	6.0541	4.2977	101.8432	29.0426	41:38:42.3	88:03:14.73
Basis	Actual	SWC	SWC	SWC	SWC	Actual	SWC	SWC	Actual	Actual
Scenario 2 Max Emis. Event	60.6552	334.2117	337.2591	9.8718	8.1794	4.2977	89.6783	28.6020	41:38:42.3	88:03:14.73
(Basis	Actual	Max E.R Event	Max E.R. Event	Max E.R. Event	Max E.R. Event	Actual	Max E.R.	Max E. R. Event	Actual	Actual
Scenario 3 Min T, V	60.6552	333.1145	332.5474	6.5699	7.9805	4.2977	34.7394	10.4908	41:38:42.3	88:03:14.73
Basis	Actual	Min Velocity Event	Min T	Min Velocity Event	Min T, V Event	Actual	Min Velocity Event	Min Velocity Event	Actual	Actual

The following were entered into U.S. EPA's AERMOD modeling system (version 23132) to determine the ambient CO impacts of FCCU startup events.

- Dispersion modeling inputs shown above.
- 5-year meteorological data set (2018-2022, provided by Illinois EPA
  - Surface data from Chicago's O'Hare International Airport
  - Upper air data from National Weather Service Forecast Office in Davenport Iowa
- Terrain elevations determined by AERMAP.
- Fenceline receptors and Cartesian receptor grids of decreasing density with increasing distance from the refinery

Background concentrations for purposes of comparison with the NAAQS were based on the 2-year average ppm concentration values for 2021 to 2023 for the Illinois EPA's CO ambient monitor located in Lansing, Illinois. This monitor is believed to be conservative, as it is located adjacent to a heavy trafficked interstate roadway, I-80/94, just west of Torrence Avenue in Lansing. Due to its proximity to this roadway, it is likely that the Lansing monitor measures extensive levels of vehicle emissions. The closest expressway to the Lemont Refinery FCCU is two miles away (I-355) and is not as heavily trafficked as I-80/94. Additionally, the two nearest industrial facilities (Oxbow and Will County Generating Station) were shut down in November 2013 and June 2022, respectively. Thus, the concentrations for the Lansing monitor are believed a conservative basis for background concentration for the Lemont Refinery.

Building heights, locations, and dimensions were incorporated into the model's building downwash algorithms.

The consultant's report provides more details regarding the model, modeling inputs, and results and is provided in Appendix C of this response.

The modeling results relative to the U.S. EPA SILs and NAAQS for CO are summarized in Tables 6, 7, and 8 below.

Table 6 shows the Lemont Refinery FCCU startup events have insignificant impacts on air quality, as the Statistical Worst Case is well below U.S. EPA's established Significant Impact Levels for Carbon Monoxide (both 1-hr and 8-hr average).

Table 6

Summary of Lemont Refinery FCCU Startup Significant Impact Level (SIL) CO Dispersion Modeling Results

	SIL Modeled CO Concentration, Maximum ($\mu g/m^3$)		*CO SIL ($\mu g/m^3$)*		*SIL-Modeled CO Concentration (Maximum) as % of SIL*	
Case	*1-hr. avg.*	*8-hr. avg.*	*1-hr. avg.*	*8-hr. avg.*	*1-hr. avg.*	*8-hr. avg.*
Statistical Worst-Case	462.57	60.49	2,000	500	23.13%	12.10%
Scenario 2 (Max emission rate event)	351.28	47.02	2,000	500	17.56%	9.40%
Scenario 3 (Minimum T, V event)	154.36	18.04	2,000	500	7.72%	3.61%

Table 7 shows the modeled FCCU startup CO ambient CO concentration along with background and shows the total concentration and the NAAQS for CO. This shows the Total CO impact with background is well below the NAAQS for CO.

Table 7

Summary of Lemont Refinery FCCU Startup Dispersion Modeling Results for Impact on CO National Ambient Air Quality Standards (NAAQS)

Case	NAAQS Modeled CO Impact, 2nd High (µg/m³)		CO Background Conc. (µg/m³)		NAAQS Modeled CO Impact (2nd High) w/ CO Background (µg/m³)		CO NAAQS (µg/m³)	
	1-hr. avg.	8-hr. avg.	1-hr. avg.	8-hr. avg.	1-hr. avg.	8-hr. avg.	1-hr. avg.	8-hr. avg.
Statistical Worst-Case	299.67	56.38	2,329.4	1,412.9	2,629.1	1,469.3	40,000	10,000
Scenario 2 (Max emission rate event)	192.31	44.31	2,329.4	1,412.9	2,521.7	1,457.2	40,000	10,000
Scenario 3 (Minimum T, V event)	97.06	17.08	2,329.4	1,412.9	2,426.5	1,430.0	40,000	10,000

Table 8, below, presents the above concentrations during FCCU startups as percentages of the CO NAAQS. This table clearly shows the estimated ambient CO concentration (background plus modeled startup emissions):

1) Increases by only 0.75% or 0.56% of the applicable CO NAAQS, depending on averaging period, and
2) Is still less than 6.6% or 14.7% of the applicable CO NAAQS, depending on averaging period.

Table 8

Comparison of Lemont Refinery FCCU Startup CO Dispersion Modeling Results with National Ambient Air Quality Standards (NAAQS) for CO

Case	CO Background as % of CO NAAQS		Modeled Impact as % of CO NAAQS		Total as % of CO NAAQS	
	1-hr. avg.	8-hr. avg.	1-hr. avg.	8-hr. avg.	1-hr. avg.	8-hr. avg.
Statistical Worst-Case	5.82%	14.1%	0.75%	0.56%	6.57%	14.7%
Scenario 2 (Max emission rate event)	5.82%	14.1%	0.48%	0.44%	6.30%	14.6%
Scenario 3 (Minimum T, V event)	5.82%	14.1%	0.24%	0.17%	6.07%	14.3%

IV. CONCLUSIONS

The above information is summarized below, with key points italicized:

- *The Lemont Refinery FCCU is a partial burn design unit with a CO Boiler, but operates as a full burn unit, still utilizing the CO Boiler.*
- From the period from 2015 through 2023, the following non-routine operations were noted:

Mode	*Includes hot standby?*	*Number of events*	*Excess CO?*
Startups associated with refractory dry-out (*i.e.*, after a maintenance turnaround)	Yes	2	Yes
Startups not associated with refractory dry-out (*i.e.*, after unit trips)	Yes	4	Yes
CO Boiler outages not associated with unit shutdown	No	6	No
Hot Standby not associated with startups	Yes	1	No

  - Startups, whether following a maintenance turnaround or a unit trip:
    - Typically have a period of Hot Standby (Torch Oil (Light Cycle Oil) operation) to warm the regenerator before introducing Fresh Feed (Gas Oil).
    - Observed duration of startups ranged from 5 to 106 hours.
    - *Excess CO during startups is typically relatively short in duration, usually 1-2 hours.*
    - Excess CO (relative to 200 ppmv @ 50% excess air) during startups (whether associated with refractory dry-out or not) generally occurs when:
      - Torch Oil (Light Cycle Oil) is warming the regenerator before introducing Fresh Feed, and
      - The Regenerator Flue Gas is in the process of being redirected back to the CO Boiler. During this period, Regenerator Flue Gas:
        - Is cooler than the CO Boiler firebox.
        - Disrupts the CO boiler flame patterns during reintroduction.
  - *CO boiler outages due to boiler trips and shutdowns not associated with unit shutdowns don't have excess CO because the FCCU is already operating as a full-burn unit.*
    - During this mode, the unit is subject to the state CO standard of 750 ppmv @ 50% excess air at 35 IAC 216.361(b), as stated in permit.[8]

[8] See footnote 6

        - But the FCCU must still comply with U.S. EPA's standard of 500 ppmv @ 0% O_2 pursuant to 40 CFR 63 Subpart UUU.
    - *The one Hot Standby event not associated with startups didn't show excess CO because the regenerator was already up to temperature, and the diversion out of and back into the CO Boiler was very brief.*

- *Dispersion modeling shows excess CO emissions from the Lemont Refinery FCCU during startup events have insignificant impact on ambient CO concentrations.*
    - Worst-case startup parameters were developed from a statistical review of startup events having excess CO.
    - *Dispersion modeling of the statistically derived worst-case scenario showed the impact of the CO during startup is insignificant*:
        - 23% of U.S. EPA's 1-hr average Significant Impact Level for CO (SIL = 2,000 $\mu g/m^3$).
        - 12% of U.S. EPA's 8-hr average SIL for CO (SIL = 500 $\mu g/m^3$).
    - Relative to the NAAQS for CO:
        - *The change in ambient air quality associated with startups is small*, increasing by:
            - 300 $\mu g/m^3$ (1-hr average), which his 0.75& of the corresponding CO NAAQS (40,000 $\mu g/m^3$).
            - 56 $\mu g/m^3$ (8-hr average), which is 0.56% of the corresponding CO NAAQS (10,000 $\mu g/m^3$).
        - Background was conservatively estimated using the IEPA's Lansing, Illinois ambient CO monitor (This monitor is situated adjacent to I-80/94, a very heavily trafficked expressway; the expressways near the Lemont Refinery (I-355 and I-55) are 2 to 2.5 miles away.
        - Conservatively utilizing the IEPA's Lansing, Illinois ambient CO monitor as representative of background concentration, the estimated ambient air quality during startup (background + statistical worst case modeled concentration during startups) is still only:
            - 6.57% of the 1-hr average CO NAAQS, and
            - 14.7% of the 8-hr average CO NAAQS.

Appendix A

Data Tables

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Table A1-1

Hourly Average Data Associated with Startup Following 2015 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
7/21/15 00:00	0	0	0	Feed out	559.7	11.2	0	0	10.0	2.8	2.08	85.6	19,216.1	18,595.0	0	0	10.3	0	0	
7/21/15 01:00	0	0	0	Feed out	559.7	11.2	0	0	10.0	3.1	2.12	84.5	19,593.1	19,000.6	0	0	10.3	0	0	
7/21/15 02:00	0	0	0	Feed out	559.7	11.2	0	0	10.0	3.1	2.15	84.8	19,868.1	19,253.8	0	0	10.3	0	0	
7/21/15 03:00	0	0	0	Feed out	559.7	11.2	0	0	10.0	3.2	2.34	84.7	21,646.1	20,982.9	0	0	10.3	0	0	
7/21/15 04:00	0	0	0	Feed out	559.8	11.2	0	0	10.0	4.1	3.24	90.5	29,883.5	28,662.5	0	0	10.4	0	0	Turn on CO Boiler FD fans (E.)
7/21/15 05:00	0	0	0	Feed out	559.8	11.2	0	0	10.0	5.5	5.12	98.7	47,281.6	44,684.6	0	0	10.6	0	0	
7/21/15 06:00	0	0	0	Feed out	559.8	11.2	0	0	10.0	5.0	6.29	95.6	58,054.8	55,164.8	0	0	10.5	0	0	
7/21/15 07:00	0	0	0	Feed out	559.8	11.2	0	14.8	9.1	5.2	8.05	92.7	74,356.3	71,025.0	4.57	15.6	9.6	28.8	19.2	CEMS daily validation
7/21/15 08:00	0	0	0	Feed out	559.8	11.2	0	0	10.0	4.6	6.03	90.5	55,649.3	53,369.0	0	0	10.5	0	0	
7/21/15 09:00	0	0	0	Feed out	560.0	11.2	0	0	10.0	4.8	6.04	90.1	55,800.7	53,561.4	0	0	10.5	0	0	
7/21/15 10:00	1.3	0	0	Feed out	560.0	11.2	0	0	10.0	5.1	6.09	91.3	56,291.7	53,911.5	0	0	10.5	0	0	Bump main air blower
7/21/15 11:00	2.6	0	0	Feed out	559.9	11.2	0	0	10.0	5.2	6.24	92.4	57,627.6	55,083.1	0	0	10.5	0	0	
7/21/15 12:00	0	2.2	0	Feed out	559.9	11.2	0	0	10.0	5.8	6.50	96.0	60,067.3	57,038.3	0	0	10.6	0	0	Start fuel gas to air heater
7/21/15 13:00	0	38.3	0	Feed out	559.9	11.2	0	0	10.0	6.9	6.65	102.1	61,399.5	57,674.2	0	0	10.7	0	0	
7/21/15 14:00	3.4	46.4	0	Feed out	560.0	11.2	0	0	10.0	8.6	7.64	110.1	70,558.8	65,346.6	0	0	10.9	0	0	Start main air blower
7/21/15 15:00	82.5	94.6	0	Feed out	560.1	11.2	0	0	10.0	9.2	14.33	112.4	132,392.0	122,124.5	0	0	11.0	0	0	
7/21/15 16:00	116.9	170.5	0	Feed out	560.1	11.2	0	0	10.0	8.2	17.80	107.7	164,405.2	152,894.0	0	0	10.9	0	0	
7/21/15 17:00	135.4	161.7	0	Feed out	560.1	11.2	0	0	10.0	8.6	19.81	109.6	183,012.8	169,637.0	0	0	10.9	0	0	
7/21/15 18:00	135.6	119.3	0	Feed out	560.1	11.2	0	0	10.0	9.3	20.28	112.1	187,319.2	172,882.6	0	0	11.0	0	0	
7/21/15 19:00	136.1	80.9	0	Feed out	560.1	11.2	0	0	10.0	10.1	22.27	114.5	205,717.7	189,043.0	0	0	11.1	0	0	
7/21/15 20:00	141.0	26.0	0	Feed out	560.1	11.2	0	0	10.0	10.6	23.49	116.9	216,923.3	198,529.8	0	0	11.2	0	0	
7/21/15 21:00	140.5	12.8	0	Feed out	560.1	11.2	0	0	10.0	10.5	24.47	118.0	226,000.6	206,427.5	0	0	11.2	0	0	Begin fuel gas to CO Boiler
7/21/15 22:00	140.1	9.0	0	Feed out	560.1	11.2	0	3.1	10.0	10.5	26.34	118.4	243,273.3	222,046.7	3.03	3.5	11.2	7.5	5.0	
7/21/15 23:00	140.2	1428.6	0	Feed out	560.1	11.2	0	7.1	10.0	10.8	26.51	119.9	244,823.5	222,881.0	6.87	7.9	11.2	17.1	11.4	
7/22/15 00:00	140.2	896.5	0	Feed out	560.1	11.2	0	9.5	10.0	12.6	26.41	125.0	243,888.3	220,122.3	9.14	10.9	11.4	24.0	16.0	
7/22/15 01:00	140.1	949.6	0	Feed out	560.1	11.2	0	0	10.0	14.8	26.27	130.1	242,622.5	217,062.4	0	0	11.7	0	0	
7/22/15 02:00	140.1	1222.7	0	Feed out	587.0	11.2	0	0	10.0	16.4	26.52	133.5	244,932.0	217,897.5	0	0	12.0	0	0	
7/22/15 03:00	144.1	1262.2	0	Feed out	668.6	11.2	0	0	10.0	17.5	28.90	135.9	266,963.4	236,531.8	0	0	12.1	0	0	
7/22/15 04:00	145.5	1256.6	0	Feed out	685.0	11.2	0	0	10.0	17.9	32.65	136.4	301,585.9	266,965.6	0	0	12.2	0	0	
7/22/15 05:00	142.9	1260.3	0	Feed out	683.0	11.2	0	0	10.0	18.7	31.45	138.0	290,454.8	256,457.1	0	0	12.3	0	0	
7/22/15 06:00	142.9	1257.5	0	Feed out	681.6	11.2	0	0	10.0	18.8	31.65	138.0	292,360.6	258,124.5	0	0	12.3	0	0	
7/22/15 07:00	142.9	1256.7	0	Feed out	685.8	11.2	0	13.3	9.1	19.2	31.77	138.7	293,393.2	258,741.8	15.03	16.5	11.3	35.8	23.9	CEMS daily validation
7/22/15 08:00	142.8	1237.0	0	Feed out	687.6	11.2	0	0	10.0	20.1	31.95	138.8	295,088.6	260,188.2	0	0	12.5	0	0	
7/22/15 09:00	142.8	1236.9	0	Feed out	689.5	11.2	0	0	10.0	20.2	31.69	138.6	292,653.3	258,111.7	0	0	12.5	0	0	
7/22/15 10:00	142.7	1240.1	0	Feed out	693.3	11.2	0	0	10.0	20.7	31.95	139.3	295,136.6	260,024.0	0	0	12.6	0	0	
7/22/15 11:00	142.6	1238.7	0	Feed out	694.6	11.2	0	0	10.0	21.1	31.84	139.9	294,079.5	258,822.0	0	0	12.7	0	0	
7/22/15 12:00	137.3	1193.0	0	Feed out	687.4	11.2	0	0	10.0	21.7	31.58	140.8	291,684.7	256,325.5	0	0	12.8	0	0	

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Table A1-1

Hourly Average Data Associated with Startup Following 2015 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
7/22/15 13:00	125.2	1188.5	0	Feed out	699.3	8.7	0	0	10.0	22.0	33.03	141.0	305,089.5	268,018.4	0	0	12.8	0	0	
7/22/15 14:00	122.3	1172.1	0	Feed out	734.8	11.2	0.27	4.1	10.0	22.5	33.73	142.7	311,496.2	272,886.3	4.84	5.2	12.9	13.7	9.1	
7/22/15 15:00	122.2	1129.5	0	Feed out	773.0	11.2	0.27	0	10.0	23.0	30.79	143.8	284,388.0	248,677.8	0	0	13.0	0	0	
7/22/15 16:00	122.2	1165.4	0	Feed out	815.8	11.2	0.27	0	10.0	23.1	30.84	144.2	284,841.5	248,919.1	0	0	13.0	0	0	
7/22/15 17:00	122.2	1154.6	0	Feed out	849.4	11.2	0.27	0	10.0	23.8	29.51	145.0	272,585.2	237,879.3	0	0	13.1	0	0	
7/22/15 18:00	122.2	1148.7	0	Feed out	863.6	11.2	0.27	0	10.0	24.0	29.30	145.2	270,643.5	236,107.8	0	0	13.2	0	0	
7/22/15 19:00	122.3	1145.2	0	Feed out	847.3	11.2	0.27	0	10.0	23.7	29.12	144.8	268,980.4	234,819.4	0	0	13.1	0	0	
7/22/15 20:00	122.3	1132.0	0	Feed out	830.6	11.2	0.27	0	10.0	23.2	28.96	144.6	267,511.0	233,587.3	0	0	13.0	0	0	
7/22/15 21:00	122.6	1132.6	0	Feed out	816.4	11.2	0.27	0	10.0	23.1	28.87	144.5	266,606.0	232,851.3	0	0	13.0	0	0	
7/22/15 22:00	122.7	1128.0	0	Feed out	812.1	11.2	0.27	0	10.0	23.2	28.97	144.6	267,537.0	233,611.6	0	0	13.0	0	0	
7/22/15 23:00	122.8	1106.9	0	Feed out	788.4	11.2	0.27	0.2	10.0	22.9	28.79	144.1	265,920.7	232,419.3	0.18	0.2	13.0	0.6	0.4	
7/23/15 00:00	122.7	1122.2	0	Feed out	792.3	11.2	0.27	0	10.0	23.0	29.92	144.2	276,330.5	241,460.0	0	0	13.0	0	0	
7/23/15 01:00	122.6	1133.8	0	Feed out	839.7	11.2	0.27	0	10.0	24.0	32.82	145.2	303,089.7	264,416.2	0	0	13.2	0	0	
7/23/15 02:00	122.9	1141.7	0	Feed out	794.4	11.2	0.27	0.1	10.0	23.3	33.66	144.3	310,857.8	271,599.7	0.08	0.1	13.0	0.2	0.1	
7/23/15 03:00	123.0	1126.8	0	Feed out	717.3	11.2	0.27	8.4	10.0	22.3	33.62	142.5	310,537.7	272,097.4	9.92	10.8	12.9	28.0	18.6	
7/23/15 04:00	123.1	1144.5	0	Feed out	662.0	11.2	0.27	7.5	10.0	22.5	33.79	143.0	312,100.7	273,268.6	8.89	9.6	12.9	25.1	16.8	
7/23/15 05:00	123.0	1141.6	0	Feed out	673.4	11.2	0.27	16.0	10.0	21.7	33.64	142.3	310,670.6	272,338.8	19.01	20.5	12.8	52.6	35.1	
7/23/15 06:00	123.2	1142.9	0	Feed out	741.8	11.2	0.27	13.2	10.0	22.9	33.63	143.3	310,616.0	271,817.0	15.68	17.2	13.0	45.2	30.2	
7/23/15 07:00	123.0	1127.9	0	Feed out	765.6	11.2	0.27	19.3	9.1	22.7	33.33	144.1	307,880.1	269,072.3	22.68	25.0	11.8	57.3	38.2	CEMS daily validation
7/23/15 08:00	122.6	1139.3	0	Feed out	777.0	11.2	0.27	0.5	10.0	22.9	33.07	144.3	305,414.4	266,818.4	0.57	0.6	13.0	1.7	1.1	
7/23/15 09:00	122.3	1133.2	0	Feed out	754.9	11.2	0.19	5.2	10.0	24.4	33.64	146.0	310,698.4	270,663.7	6.15	6.9	13.2	18.8	12.5	
7/23/15 10:00	122.2	1128.7	0	Feed out	683.9	11.2	0.19	3.8	10.0	22.1	32.51	142.7	300,276.2	263,022.7	4.37	4.9	12.8	12.7	8.4	
7/23/15 11:00	122.1	1119.6	0	Feed out	679.5	11.2	0.19	2.6	10.0	22.6	32.51	143.0	300,237.5	262,866.1	2.93	3.3	12.9	8.7	5.8	
7/23/15 12:00	122.0	1115.2	0	Feed out	741.5	11.2	0.19	10.0	10.0	23.3	32.25	143.9	297,862.3	260,396.7	11.36	13.0	13.0	34.7	23.1	
7/23/15 13:00	121.6	1117.0	0	Feed out	795.5	11.2	0.19	5.6	10.0	23.0	32.07	143.8	296,208.7	258,991.3	6.37	7.3	13.0	19.3	12.9	
7/23/15 14:00	121.3	957.9	403.09	Feed out	931.8	11.2	33.18	349.7	10.0	23.6	33.50	144.5	309,381.2	270,189.3	412.13	457.9	13.1	1226.2	817.5	Start torch oil, begin diverting to CO Boiler
7/23/15 15:00	121.3	102.4	377.73	Feed out	1219.1	10.9	100.18	11.8	10.0	23.2	33.48	144.0	309,252.6	270,338.6	13.94	15.4	13.0	40.8	27.2	
7/23/15 16:00	121.2	96.7	417.10	Feed out	1157.4	11.2	100.18	53.6	10.0	23.4	31.47	144.4	290,669.2	253,921.7	59.33	69.9	13.0	186.1	124.1	
7/23/15 17:00	121.3	91.0	556.72	Feed out	1155.6	11.2	100.18	62.0	10.0	24.1	31.43	145.3	290,300.6	253,220.3	68.53	81.7	13.2	221.1	147.4	
7/23/15 18:00	121.4	84.6	415.21	Feed out	1148.9	11.2	100.18	19.9	10.0	24.2	30.82	145.4	284,652.2	248,222.8	21.56	26.3	13.2	71.3	47.5	
7/23/15 19:00	121.4	82.9	532.20	Feed out	1055.9	11.2	100.18	43.1	10.0	23.8	28.37	144.7	262,034.4	228,767.4	43.06	56.6	13.1	151.6	101.0	
7/23/15 20:00	121.3	105.6	553.49	Feed out	1170.6	11.2	100.18	9.5	10.0	24.0	25.51	146.2	235,615.3	205,212.4	8.53	12.5	13.2	33.9	22.6	
7/23/15 21:00	121.6	117.7	515.78	Feed out	1203.3	11.2	100.18	2.6	10.0	23.4	26.07	145.7	240,746.7	209,852.7	2.34	3.3	13.0	8.9	5.9	
7/23/15 22:00	121.7	93.8	483.77	Feed out	1196.1	11.2	100.18	1.5	10.0	23.4	25.52	145.4	235,725.4	205,555.0	1.38	2.0	13.1	5.4	3.6	
7/23/15 23:00	121.8	69.1	459.97	Feed out	1200.5	11.2	100.18	0.3	10.0	23.2	24.91	145.3	230,038.8	200,630.6	0.28	0.4	13.0	1.1	0.7	
7/24/15 00:00	122.2	72.2	283.57	Feed out	1112.7	11.2	100.18	0.8	10.0	22.3	25.79	144.0	238,197.9	208,198.7	0.71	1.0	12.9	2.6	1.7	
7/24/15 01:00	122.3	83.0	538.75	Feed out	1159.0	11.2	100.18	11.1	10.0	23.0	25.64	145.2	236,799.3	206,589.9	9.99	14.4	13.0	38.0	25.3	

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Table A1-1

Hourly Average Data Associated with Startup Following 2015 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
7/24/15 02:00	122.3	72.2	402.46	Feed out	1152.8	11.2	100.18	4.5	10.0	22.5	26.92	144.5	248,685.3	217,197.8	4.30	5.9	12.9	15.3	10.2	
7/24/15 03:00	122.4	108.4	521.43	Feed out	1208.1	11.2	100.18	0.8	10.0	23.0	26.95	145.2	248,889.0	217,125.2	0.72	1.0	13.0	2.6	1.7	
7/24/15 04:00	122.4	103.1	514.97	Feed out	1260.9	11.2	100.18	0	10.0	23.1	26.73	145.6	246,904.1	215,233.9	0	0	13.0	0	0	
7/24/15 05:00	122.6	100.5	491.82	Feed out	1261.8	11.2	100.17	0	10.0	23.2	26.67	145.7	246,322.1	214,704.2	0	0	13.0	0	0	
7/24/15 06:00	122.5	93.4	546.55	Feed out	1270.8	11.2	100.18	0	10.0	23.4	26.67	146.3	246,318.9	214,505.6	0	0	13.1	0	0	
7/24/15 07:00	122.2	115.9	574.81	Feed out	1265.4	11.2	92.10	58.2	9.1	23.8	26.88	147.1	248,271.7	215,893.4	54.83	76.4	11.9	177.4	118.2	CEMS daily validation
7/24/15 08:00	121.8	119.0	383.02	Feed out	1302.1	11.2	100.18	0	10.0	23.8	25.59	146.3	236,315.6	205,770.9	0	0	13.1	0	0	
7/24/15 09:00	121.6	128.0	357.65	Feed out	1162.4	11.2	100.18	0	10.0	23.1	25.29	145.2	233,625.6	203,819.8	0	0	13.0	0	0	
7/24/15 10:00	121.4	117.8	444.02	Feed out	1122.3	11.2	100.18	0	10.0	23.1	25.28	144.7	233,459.8	203,846.8	0	0	13.0	0	0	
7/24/15 11:00	121.3	123.6	411.02	Feed out	1125.7	11.2	100.18	0	10.0	23.0	25.26	144.5	233,311.4	203,765.0	0	0	13.0	0	0	
7/24/15 12:00	121.2	101.6	456.17	Feed out	1138.2	11.2	100.18	0	10.0	23.5	25.31	145.1	233,796.5	203,986.9	0	0	13.1	0	0	
7/24/15 13:00	121.2	109.6	502.29	Feed out	1191.4	11.2	100.18	0	10.0	23.7	25.37	145.2	234,344.3	204,441.5	0	0	13.1	0	0	
7/24/15 14:00	121.1	94.0	497.53	Feed out	1243.5	11.2	100.18	0	10.0	23.9	25.41	145.3	234,713.3	204,717.9	0	0	13.1	0	0	
7/24/15 15:00	121.0	89.9	509.64	Feed out	1277.0	11.2	100.18	0	10.0	23.8	24.89	145.4	229,873.3	200,484.1	0	0	13.1	0	0	
7/24/15 16:00	120.9	97.2	419.92	Feed out	1268.9	11.2	100.18	0	10.0	23.0	24.40	144.3	225,356.3	196,875.0	0	0	13.0	0	0	
7/24/15 17:00	121.0	111.9	462.73	Feed out	1198.1	11.2	94.89	40.9	10.0	22.7	24.70	144.1	228,118.7	199,381.4	35.60	52.9	12.9	138.8	92.5	
7/24/15 18:00	121.1	96.8	568.69	Feed out	1256.9	11.2	100.18	0	10.0	23.1	24.90	145.0	229,993.9	200,718.2	0	0	13.0	0	0	
7/24/15 19:00	121.1	94.8	630.58	Feed out	1239.0	11.2	100.18	0	10.0	23.6	25.26	145.5	233,307.0	203,441.5	0	0	13.1	0	0	
7/24/15 20:00	121.3	97.3	557.76	Feed out	1280.6	11.2	100.18	0	10.0	23.6	25.22	145.9	232,897.9	202,948.3	0	0	13.1	0	0	
7/24/15 21:00	121.4	90.2	732.40	Feed out	1223.2	11.2	100.18	0	10.0	23.7	25.11	146.0	231,919.4	202,051.9	0	0	13.1	0	0	
7/24/15 22:00	121.5	96.9	578.81	Feed out	1265.1	11.2	100.18	0	10.0	23.4	25.22	145.9	232,958.3	203,004.1	0	0	13.0	0	0	
7/24/15 23:00	121.5	100.7	522.23	Feed out	1225.2	11.2	100.18	0	10.0	23.0	25.16	145.7	232,356.9	202,518.7	0	0	13.0	0	0	
7/25/15 00:00	121.5	98.6	679.59	Feed out	1171.1	11.2	100.18	0.3	10.0	23.0	25.24	146.0	233,088.7	203,075.9	0.25	0.4	13.0	1.0	0.6	
7/25/15 01:00	121.5	97.0	632.59	Feed out	1200.9	11.2	100.18	0	10.0	24.9	25.96	148.9	239,815.5	207,936.0	0	0	13.3	0	0	
7/25/15 02:00	121.6	108.9	636.34	Feed out	1198.4	11.2	100.18	0	10.0	24.6	26.02	148.6	240,367.2	208,522.1	0	0	13.3	0	0	
7/25/15 03:00	121.6	112.6	557.18	Feed out	1173.2	11.2	100.18	0	10.0	24.4	25.98	148.5	239,912.9	208,154.4	0	0	13.2	0	0	
7/25/15 04:00	121.6	130.5	583.02	Feed in, low rate	1185.2	11.2	100.18	0	10.0	24.8	26.18	149.3	241,815.7	209,521.9	0	0	13.3	0	0	Begin fresh feed to FCCU
7/25/15 05:00	121.6	116.3	707.53		1214.2	11.2	100.18	0	10.0	25.1	26.15	149.8	241,542.9	209,116.1	0	0	13.4	0	0	
7/25/15 06:00	121.7	134.7	646.71		1308.6	11.2	100.16	0	10.0	25.7	26.23	150.3	242,292.7	209,592.5	0	0	13.4	0	0	
7/25/15 07:00	121.5	125.5	467.43		1217.0	11.2	100.16	15.5	9.1	25.0	26.07	149.8	240,779.4	208,471.9	14.11	20.7	12.1	49.2	32.8	CEMS daily validation
7/25/15 08:00	121.3	129.8	593.28		1113.9	11.2	100.18	0	10.0	25.1	26.30	149.8	242,927.0	210,332.9	0	0	13.4	0	0	Cut fresh feed
7/25/15 09:00	121.1	150.6	713.61	Feed out	1220.0	11.2	100.18	0	10.0	24.6	26.02	149.9	240,295.8	208,006.3	0	0	13.3	0	0	
7/25/15 10:00	120.9	157.5	554.75	Feed in, low rate	1229.8	11.2	100.18	0	10.0	24.5	26.08	150.1	240,886.6	208,455.8	0	0	13.3	0	0	Reintroduce, and then cut, fresh feed
7/25/15 11:00	120.5	153.3	680.45	Feed out	1160.4	11.2	100.18	0	9.8	25.2	25.81	151.1	238,376.7	205,937.9	0	0	13.1	0	0	
7/25/15 12:00	119.5	170.4	602.41	Feed in, low rate	1221.6	10.0	100.17	0	8.5	26.9	26.33	153.0	243,222.1	209,465.1	0	0	11.7	0	0	Reintroduce fresh feed
7/25/15 13:00	59.4	0	299.14		1187.8	10.7	22.49	142.3	8.9	28.0	20.41	154.1	188,486.9	162,039.3	100.57	197.7	12.4	484.1	322.8	Cut fuel gas to air heater

Electronic Filing: Received, Clerk's Office 03/15/2024 P.C. #15

Table A1-1

Hourly Average Data Associated with Startup Following 2015 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
7/25/15 14:00	120.4	0	687.70	low rate	1109.5	11.1	100.17	0	9.6	26.3	29.19	151.4	269,609.2	232,819.9	0	0	13.0	0	0	Reintroduce fresh feed, cut torch oil
7/25/15 15:00	119.6	0	0		1258.0	4.4	100.17	0	7.3	28.8	32.67	152.9	301,736.2	259,924.5	0	0	10.3	0	0	Nominal normal operation achieved. End startup.
7/25/15 16:00	119.2	0	0		1245.7	1.2	100.17	0	6.6	29.1	30.23	153.1	279,167.8	240,398.4	0	0	9.3	0	0	
7/25/15 17:00	119.8	0	0		1217.6	0	100.17	9.3	6.7	28.2	29.95	152.5	276,647.5	238,453.0	9.72	13.0	9.3	23.4	15.6	
7/25/15 18:00	120.1	0	0		1201.0	0	100.17	4.3	6.7	27.3	30.52	151.3	281,907.6	243,476.2	4.56	5.9	9.2	10.6	7.1	
7/25/15 19:00	120.3	0	0		1194.2	0	100.17	15.3	6.8	27.4	30.56	151.6	282,264.5	243,644.3	16.29	21.1	9.4	38.3	25.5	
7/25/15 20:00	120.7	0	0		1181.4	0	100.15	0	6.3	27.8	30.49	152.1	281,622.6	242,915.0	0	0	8.8	0	0	
7/25/15 21:00	121.1	0	0		1204.5	0	100.13	0	6.7	27.5	30.04	151.3	277,502.5	239,650.9	0	0	9.2	0	0	
7/25/15 22:00	121.3	0	0		1208.3	0	100.11	0	6.7	27.8	30.43	151.4	281,105.8	242,750.2	0	0	9.2	0	0	
7/25/15 23:00	120.4	0	0		1211.5	0	100.10	0	6.7	27.6	30.49	151.3	281,569.2	243,195.4	0	0	9.3	0	0	
7/26/15 00:00	120.2	0	0		1201.2	0	100.10	0	6.7	27.8	30.49	151.4	281,574.3	243,130.2	0	0	9.3	0	0	
7/26/15 01:00	120.4	0	0		1197.0	0	100.10	0	6.4	29.2	30.90	152.8	285,426.2	245,888.8	0	0	9.0	0	0	
7/26/15 02:00	120.6	0	0		1196.0	0	100.11	0	6.4	29.4	31.42	153.0	290,209.0	249,963.8	0	0	9.0	0	0	
7/26/15 03:00	120.3	0	0		1187.9	0	100.11	0	6.4	29.2	31.77	152.9	293,396.4	252,719.0	0	0	9.0	0	0	
7/26/15 04:00	120.4	0	0		1175.5	0	100.11	0	6.4	29.4	31.58	152.6	291,723.0	251,416.8	0	0	9.1	0	0	
7/26/15 05:00	120.5	0	0		1169.2	0	100.10	0	6.1	29.7	30.53	152.7	281,961.3	242,952.1	0	0	8.6	0	0	
7/26/15 06:00	120.5	0	0	Nominal normal operating rate	1187.5	0.0	100.09	0	6.4	29.8	30.71	152.8	283,660.1	244,393.9	0	0	9.1	0	0	
7/26/15 07:00	120.5	0	0		1180.4	0	100.11	16.3	5.9	29.4	31.18	153.4	287,960.8	247,834.8	17.63	23.1	8.3	38.4	25.6	CEMS daily validation
7/26/15 08:00	120.2	0	0		1170.8	0.0	100.13	0	6.5	30.1	32.24	153.2	297,762.9	256,360.7	0	0	9.4	0	0	
7/26/15 09:00	120.0	0	0		1156.9	0.2	100.15	0	6.4	30.6	32.18	153.6	297,226.2	255,743.4	0	0	9.2	0	0	
7/26/15 10:00	119.9	0	0		1145.7	0	100.17	0	6.3	31.0	32.42	154.0	299,439.7	257,478.2	0	0	9.2	0	0	
7/26/15 11:00	120.0	0	0		1152.2	0	100.18	0	6.7	31.1	32.70	153.7	302,067.1	259,867.3	0	0	9.8	0	0	
7/26/15 12:00	119.9	0	0		1154.1	0	100.18	0	6.8	30.4	32.62	153.0	301,313.5	259,524.9	0	0	9.7	0	0	
7/26/15 13:00	119.8	0	0		1171.7	0	100.18	0	6.7	30.3	32.62	153.0	301,275.0	259,483.7	0	0	9.6	0	0	
7/26/15 14:00	119.7	0	0		1196.4	0	100.18	0	6.9	29.6	33.29	152.1	307,512.7	265,233.4	0	0	9.8	0	0	
7/26/15 15:00	119.6	0	0		1197.2	0	100.18	0	7.0	29.3	33.21	152.2	306,706.3	264,491.1	0	0	9.9	0	0	
7/26/15 16:00	119.5	0	0		1192.0	0	100.18	0	6.6	29.8	32.76	153.3	302,581.1	260,457.8	0	0	9.4	0	0	
7/26/15 17:00	119.7	0	0		1179.2	0	100.18	0	6.7	29.9	32.91	153.5	303,998.3	261,600.1	0	0	9.6	0	0	
7/26/15 18:00	119.7	0	0		1177.2	0	100.18	0	6.6	29.0	32.27	152.3	298,016.2	256,960.7	0	0	9.3	0	0	
7/26/15 19:00	119.8	0	0		1180.5	0	100.18	0	6.9	27.5	30.50	150.7	281,737.6	243,552.5	0	0	9.5	0	0	
7/26/15 20:00	119.8	0	0		1177.6	0	100.16	0	6.6	26.8	29.12	149.9	268,983.8	232,829.8	0	0	9.0	0	0	
7/26/15 21:00	119.8	0	0		1177.8	0	100.14	0	6.5	26.0	28.50	147.8	263,272.1	228,687.3	0	0	8.8	0	0	
7/26/15 22:00	120.0	0	0		1171.0	0	100.13	0	6.4	27.7	28.78	150.3	265,805.6	229,959.2	0	0	8.9	0	0	
7/26/15 23:00	120.2	0	0		1170.8	0	100.12	0	6.5	27.6	28.70	150.7	265,059.6	229,134.1	0	0	9.0	0	0	

Table A1-1

Hourly Average Data Associated with Startup Following 2015 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
During Hot standby/startup																				
Total															999.27					
Average															9.99	12.60	12.62	32.58	21.72	
Maximum															412.13	457.93	13.45	1226.20	817.46	
Standard Deviation															43.50	51.29	0.77	135.41	90.27	
Average + 2 SD															96.99	115.18	14.17	303.40	202.26	
Post startup																				
Total															48.21					
Average															1.46	1.91	9.26	3.35	2.23	
Maximum															17.63	23.11	10.31	38.40	25.60	
Standard Deviation															4.41	5.77	0.39	10.04	6.69	
Average + 2 SD															10.27	13.45	10.04	23.43	15.62	

Table A1-2

Hourly Average Data Associated with Startup Following 2020 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*	*BPD*	*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
7/12/20 00:00	0	0	0	Feed out	124.3	11.3	0.12	0	8.3	12.9	19.64	146.5	181,364.2	157,874.8	0	0	9.6	0	0	
7/12/20 01:00	0	0	0	Feed out	122.3	11.3	0.12	0	8.4	13.1	18.52	146.3	171,068.8	148,970.6	0	0	9.7	0	0	
7/12/20 02:00	0	0	0	Feed out	121.4	11.3	0.12	0	8.5	12.6	18.27	146.8	168,737.2	146,824.2	0	0	9.7	0	0	
7/12/20 03:00	0	0	0	Feed out	120.9	11.3	0.12	0	8.5	12.5	18.75	146.6	173,175.0	150,714.5	0	0	9.7	0	0	
7/12/20 04:00	0	0	0	Feed out	119.5	11.3	0.12	0	8.4	12.7	18.68	147.1	172,570.0	150,062.5	0	0	9.7	0	0	
7/12/20 05:00	0	0	0	Feed out	118.0	11.3	0.12	0	8.4	12.5	18.80	147.2	173,640.0	150,974.0	0	0	9.7	0	0	
7/12/20 06:00	0	0	0	Feed out	117.9	11.3	0.12	0	8.5	12.6	18.75	147.2	173,149.5	150,552.7	0	0	9.7	0	0	
7/12/20 07:00	0	0	0	Feed out	142.6	11.3	0.12	0	8.5	13.8	18.93	147.8	174,864.7	151,894.4	0	0	9.9	0	0	
7/12/20 08:00	0	0	0	Feed out	166.5	11.3	0.12	14.4	7.9	13.2	18.51	148.0	170,960.6	148,455.3	9.31	16.6	9.1	29.2	19.5	CEMS daily validation
7/12/20 09:00	4.2	0	0	Feed out	177.4	11.3	0.12	0	8.7	13.9	18.67	147.5	172,455.1	149,871.0	0	0	10.1	0	0	
7/12/20 10:00	117.9	0	0	Feed out	193.7	11.3	0.12	0	10.0	15.8	30.39	139.8	280,670.2	247,055.5	0	0	11.9	0	0	
7/12/20 11:00	118.1	0	0	Feed out	252.3	11.3	0.12	0	10.0	15.9	30.55	136.8	282,197.9	249,657.9	0	0	11.9	0	0	
7/12/20 12:00	118.0	0	0	Feed out	280.0	11.3	0.12	0	10.0	16.1	31.04	136.8	286,713.9	253,631.8	0	0	11.9	0	0	
7/12/20 13:00	118.0	0	0	Feed out	297.8	11.3	0.12	0	10.0	16.5	32.57	137.7	300,833.8	265,715.0	0	0	12.0	0	0	
7/12/20 14:00	118.0	0	0	Feed out	307.8	11.3	0.12	0	10.0	16.9	33.47	138.8	309,118.6	272,552.6	0	0	12.0	0	0	
7/12/20 15:00	118.0	0	0	Feed out	311.5	11.3	0.12	0	10.0	17.3	32.68	139.5	301,884.0	265,853.5	0	0	12.1	0	0	
7/12/20 16:00	118.1	0	0	Feed out	313.6	11.3	0.12	0	10.0	16.2	32.06	137.3	296,144.8	261,752.3	0	0	11.9	0	0	
7/12/20 17:00	118.4	0	0	Feed out	306.4	11.3	0.12	0	10.0	16.0	30.37	137.4	280,486.4	247,863.9	0	0	11.9	0	0	
7/12/20 18:00	118.6	0	0	Feed out	299.3	11.3	0.12	0	10.0	16.0	30.11	137.4	278,086.5	245,754.3	0	0	11.9	0	0	
7/12/20 19:00	118.8	0	0	Feed out	296.0	11.3	0.12	0	10.0	15.6	30.31	137.5	279,969.9	247,371.2	0	0	11.8	0	0	
7/12/20 20:00	118.9	0	0	Feed out	294.3	11.3	0.12	0	10.0	15.3	30.54	137.4	282,119.3	249,347.2	0	0	11.8	0	0	
7/12/20 21:00	119.1	138.2	0	Feed out	292.6	11.3	0.12	0	10.0	14.9	30.40	137.3	280,819.8	248,232.2	0	0	11.8	0	0	Start fuel gas to air heater
7/12/20 22:00	119.1	129.1	0	Feed out	291.9	11.3	0.12	0	10.0	14.4	30.48	137.2	281,513.1	248,864.1	0	0	11.7	0	0	Shut down fuel gas to air heater
7/12/20 23:00	119.2	0	0	Feed out	291.0	11.3	0.12	0	10.0	14.5	30.70	137.2	283,540.8	250,671.5	0	0	11.7	0	0	
7/13/20 00:00	119.3	0	0	Feed out	290.1	11.3	0.12	0	10.0	15.3	31.01	137.3	286,444.5	253,205.0	0	0	11.8	0	0	
7/13/20 01:00	119.5	0	0	Feed out	288.6	11.3	0.12	0	10.0	15.9	30.68	137.2	283,398.0	250,552.6	0	0	11.9	0	0	
7/13/20 02:00	119.5	0	0	Feed out	287.3	11.3	0.12	0	10.0	16.0	30.70	137.0	283,572.6	250,789.9	0	0	11.9	0	0	
7/13/20 03:00	119.6	0	0	Feed out	286.5	11.3	0.12	0	10.0	15.9	30.85	136.9	284,909.5	251,999.1	0	0	11.9	0	0	
7/13/20 04:00	119.8	0	0	Feed out	285.4	9.4	0.12	0	10.0	15.7	30.77	136.9	284,244.1	251,425.5	0	0	11.9	0	0	
7/13/20 05:00	119.7	0	0	Feed out	285.3	7.2	0.12	0	10.0	13.6	30.76	136.9	284,134.1	251,329.9	0	0	11.6	0	0	
7/13/20 06:00	119.7	0	0	Feed out	285.7	10.9	0.12	0	10.0	15.2	30.94	137.2	285,747.3	252,629.3	0	0	11.8	0	0	
7/13/20 07:00	119.5	0	0	Feed out	286.6	11.3	0.12	0	10.0	15.1	30.43	137.2	281,082.4	248,491.3	0	0	11.8	0	0	
7/13/20 08:00	119.2	146.5	0	Feed out	288.9	11.3	0.12	15.9	8.9	15.1	30.43	137.5	281,056.5	248,362.9	17.20	18.7	10.5	37.6	25.1	CEMS daily validation, restart fuel gas to air heater
7/13/20 09:00	119.0	203.9	0	Feed out	304.0	11.3	0.12	0	10.0	15.2	30.11	137.4	278,070.4	245,731.1	0	0	11.8	0	0	
7/13/20 10:00	118.7	331.9	0	Feed out	374.8	11.3	0.12	3.3	10.0	14.6	29.95	138.4	276,644.4	244,064.5	3.56	3.9	11.7	8.9	5.9	
7/13/20 11:00	118.7	477.4	0	Feed out	431.7	11.3	0.12	12.9	10.0	15.8	29.90	139.7	276,180.4	243,159.1	13.67	15.3	11.9	35.4	23.6	
7/13/20 12:00	118.6	476.9	0	Feed out	458.0	11.3	0.12	14.9	10.0	17.5	30.18	140.4	278,709.4	245,084.1	15.98	18.1	12.1	43.2	28.8	

Electronic Filing: Received, Clerk's Office 03/15/2024 P.C. #15

Table A1-2

Hourly Average Data Associated with Startup Following 2020 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*	*BPD*	*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
7/13/20 13:00	118.6	681.1	0	Feed out	502.2	11.3	0.12	19.7	10.0	18.1	30.31	140.9	279,958.2	245,968.2	21.13	24.0	12.2	57.8	38.5	
7/13/20 14:00	118.4	737.7	0	Feed out	542.7	11.3	0.12	21.0	10.0	18.1	29.88	141.9	275,948.0	242,051.9	22.15	25.6	12.2	61.7	41.1	
7/13/20 15:00	118.5	948.4	0	Feed out	598.7	11.3	0.12	19.2	10.0	19.0	29.49	142.7	272,371.4	238,612.9	19.97	23.7	12.3	57.9	38.6	
7/13/20 16:00	118.4	770.5	0	Feed out	618.2	11.3	0.12	22.0	10.0	18.1	29.26	143.3	270,210.0	236,463.8	22.70	26.9	12.2	64.6	43.1	
7/13/20 17:00	118.4	799.4	0	Feed out	617.7	11.3	0.12	25.0	10.0	18.3	29.26	143.2	270,247.7	236,529.3	25.80	30.6	12.2	73.9	49.2	
7/13/20 18:00	118.5	815.2	0	Feed out	621.9	11.3	0.12	23.3	10.0	18.4	29.30	143.7	270,659.4	236,693.2	24.03	28.5	12.3	69.0	46.0	
7/13/20 19:00	118.6	855.7	0	Feed out	629.0	11.3	0.12	23.5	10.0	18.6	28.96	143.6	267,484.8	233,956.4	24.03	28.9	12.3	70.1	46.7	
7/13/20 20:00	118.8	875.9	0	Feed out	644.8	11.3	0.12	21.1	10.0	17.2	29.88	143.6	276,009.9	241,425.0	22.26	25.5	12.0	60.3	40.2	
7/13/20 21:00	119.1	856.8	0	Feed out	652.7	11.3	0.12	20.7	10.0	16.8	30.28	144.0	279,629.0	244,430.2	22.10	24.9	12.0	58.3	38.9	
7/13/20 22:00	119.3	826.2	0	Feed out	649.3	11.3	0.12	22.1	10.0	17.5	30.00	143.8	277,129.4	242,302.6	23.41	26.8	12.1	63.7	42.5	
7/13/20 23:00	119.3	828.9	0	Feed out	647.7	11.3	0.12	20.9	10.0	17.6	30.14	143.4	278,338.5	243,547.7	22.24	25.4	12.1	60.4	40.3	
7/14/20 00:00	119.3	962.2	0	Feed out	668.9	11.3	0.12	17.9	9.9	16.8	30.36	143.7	280,408.0	245,225.8	19.16	21.5	12.0	50.3	33.5	
7/14/20 01:00	119.5	1069.4	0	Feed out	703.2	11.3	0.12	16.1	9.8	17.1	30.44	144.3	281,169.2	245,629.9	17.29	19.5	11.9	45.0	30.0	
7/14/20 02:00	119.7	1107.1	0	Feed out	738.1	11.3	0.12	13.4	9.7	17.8	28.89	144.9	266,855.9	232,931.5	13.62	16.3	11.8	37.6	25.1	
7/14/20 03:00	119.7	1107.8	0	Feed out	764.0	11.3	0.12	13.5	9.6	16.9	28.78	145.2	265,833.2	231,894.3	13.63	16.2	11.6	36.4	24.2	
7/14/20 04:00	119.8	1094.6	0	Feed out	786.1	11.3	0.12	11.4	9.6	16.7	29.41	145.5	271,643.6	236,849.8	11.80	13.7	11.6	30.7	20.5	
7/14/20 05:00	119.8	1104.9	0	Feed out	796.9	11.3	0.12	11.0	9.7	16.1	29.25	145.7	270,197.8	235,498.4	11.28	13.1	11.5	29.2	19.4	
7/14/20 06:00	119.7	1102.9	0	Feed out	807.6	11.3	0.12	12.2	9.6	16.7	29.16	146.0	269,318.2	234,641.7	12.49	14.6	11.6	32.8	21.9	
7/14/20 07:00	119.5	1086.9	0	Feed out	808.9	11.3	0.12	11.9	9.7	17.4	29.36	146.0	271,198.2	236,274.6	12.27	14.4	11.8	33.1	22.0	
7/14/20 08:00	119.3	1092.4	0	Feed out	811.8	11.3	0.12	23.7	8.7	17.5	29.35	146.3	271,052.1	236,028.2	24.38	28.7	10.6	58.0	38.6	CEMS daily validation
7/14/20 09:00	119.1	1095.7	0	Feed out	815.3	11.3	0.12	12.7	9.6	17.4	29.95	146.9	276,608.8	240,635.4	13.32	15.4	11.6	34.4	22.9	
7/14/20 10:00	118.8	1092.5	0	Feed out	818.9	11.3	0.12	14.2	9.5	19.3	31.83	148.6	294,005.2	255,044.8	15.80	17.6	11.8	40.4	27.0	
7/14/20 11:00	118.7	1100.7	0	Feed out	819.5	11.3	0.12	17.9	9.8	19.1	32.93	147.2	304,153.1	264,454.4	20.67	22.2	12.1	52.5	35.0	
7/14/20 12:00	118.5	1096.9	0	Feed out	804.3	10.6	0.12	17.1	9.7	20.3	33.09	147.7	305,641.3	265,553.9	19.82	21.5	12.2	51.6	34.4	
7/14/20 13:00	118.4	1096.3	0	Feed out	777.2	11.3	0.12	19.0	9.8	20.8	33.05	147.2	305,268.4	265,442.1	21.96	24.0	12.4	59.0	39.4	
7/14/20 14:00	118.3	1106.9	0	Feed out	751.7	11.3	0.12	18.9	9.9	20.3	33.06	146.7	305,394.8	265,760.3	21.90	23.7	12.4	58.5	39.0	Start torch oil, begin diverting to CO Boiler
7/14/20 15:00	118.3	1104.7	0	Feed out	738.6	11.3	0.12	21.4	9.9	20.8	33.35	146.5	307,992.7	268,112.4	25.01	27.0	12.5	67.4	44.9	
7/14/20 16:00	118.2	1101.1	0	Feed out	737.0	11.3	0.12	21.7	9.9	20.9	33.10	146.7	305,753.8	266,053.0	25.14	27.4	12.5	68.0	45.3	
7/14/20 17:00	118.2	1106.2	0	Feed out	693.8	11.3	0.12	20.9	9.9	21.2	32.76	146.1	302,592.0	263,560.7	24.01	26.5	12.6	66.7	44.5	
7/14/20 18:00	118.3	1110.8	0	Feed out	677.3	11.3	0.12	16.0	10.0	20.2	32.60	145.6	301,080.1	262,495.8	18.33	20.1	12.5	49.7	33.2	
7/14/20 19:00	118.4	1090.1	0	Feed out	680.0	11.3	0.12	16.6	9.9	18.9	33.35	145.3	307,996.2	268,630.9	19.41	20.4	12.3	49.4	32.9	
7/14/20 20:00	118.5	1084.1	7.51	Feed out	684.3	11.3	0.12	16.3	9.8	18.1	32.92	144.9	304,080.2	265,386.6	18.84	19.9	12.0	46.5	31.0	
7/14/20 21:00	118.7	1083.5	59.86	Feed out	693.0	11.3	0.12	27.5	9.2	17.3	30.47	145.5	281,425.3	245,397.9	29.39	33.2	11.1	70.8	47.2	Start torch oil, begin diverting to CO Boiler
7/14/20 22:00	118.6	1076.9	358.31	Feed out	885.8	11.2	74.95	270.3	8.4	17.8	28.92	146.0	267,088.5	232,702.3	274.34	329.0	10.2	643.7	429.2	Begin diverting back to CO Boiler (Regen O2 > 1%)
7/14/20 23:00	118.4	1013.1	218.34	Feed out	1079.0	11.3	100.17	0.0	9.2	18.2	29.20	146.3	269,720.6	234,867.0	0.04	0.1	11.3	0.1	0.1	Fully-diverted back to CO Boiler
7/15/20 00:00	118.6	889.3	197.07	Feed out	1100.5	11.3	100.17	0	9.7	17.7	29.76	146.2	274,867.7	239,391.2	0	0	11.7	0	0	
7/15/20 01:00	118.5	898.0	199.20	Feed out	1092.2	11.3	100.17	0	9.6	17.7	27.05	146.5	249,856.5	217,491.3	0	0	11.7	0	0	

Table A1-2

Hourly Average Data Associated with Startup Following 2020 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*	*BPD*	*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
7/15/20 02:00	118.6	896.8	202.40	Feed out	1089.0	11.3	100.17	0	9.6	17.2	29.04	146.8	268,236.9	233,390.8	0	0	11.6	0	0	
7/15/20 03:00	118.7	605.2	218.98	Feed out	1084.6	11.3	100.17	0	9.7	17.4	27.22	145.8	251,400.6	219,104.4	0	0	11.8	0	0	
7/15/20 04:00	118.9	416.5	290.11	Feed out	1017.6	11.3	100.17	0	9.6	16.8	27.94	146.0	258,049.3	224,822.8	0	0	11.6	0	0	
7/15/20 05:00	118.8	403.3	296.66	Feed out	1000.2	11.3	100.17	0	9.6	16.4	26.76	145.9	247,165.8	215,358.8	0	0	11.5	0	0	
7/15/20 06:00	118.7	419.7	427.88	Feed out	1022.1	11.3	100.17	0	9.0	18.9	27.96	147.5	258,239.9	224,429.4	0	0	11.1	0	0	
7/15/20 07:00	118.3	413.0	407.98	Feed out	1034.2	11.3	100.17	0	9.0	17.1	27.86	148.3	257,339.9	223,337.8	0	0	10.9	0	0	
7/15/20 08:00	118.6	431.9	423.21	Feed out	1131.6	11.3	100.17	11.7	8.2	17.8	27.63	148.3	255,232.3	221,525.4	11.27	14.2	10.0	27.3	18.2	CEMS daily validation
7/15/20 09:00	118.3	428.4	385.98	Feed out	1116.1	10.6	100.17	0	9.2	18.0	27.75	148.1	256,294.7	222,529.6	0	0	11.3	0	0	
7/15/20 10:00	117.9	414.5	427.75	Feed out	1067.2	11.3	100.17	0	9.0	19.3	27.90	148.9	257,704.8	223,462.1	0	0	11.2	0	0	
7/15/20 11:00	117.4	407.6	404.95	Feed out	1079.9	11.3	100.17	0	9.0	19.4	27.69	149.2	255,749.2	221,653.2	0	0	11.2	0	0	
7/15/20 12:00	117.4	426.0	323.94	Feed out	1068.4	11.3	100.17	0.0	9.4	19.4	27.64	148.7	255,279.8	221,404.3	0.01	0.0	11.7	0.0	0.0	
7/15/20 13:00	117.5	434.5	386.89	Feed out	1039.8	11.3	100.17	0.1	9.2	18.5	27.89	148.6	257,592.0	223,465.3	0.12	0.1	11.3	0.3	0.2	
7/15/20 14:00	117.6	446.3	352.85	Feed out	1070.9	11.3	100.17	0.1	9.3	18.4	27.78	148.7	256,580.7	222,557.9	0.13	0.2	11.4	0.4	0.2	
7/15/20 15:00	117.7	422.5	315.58	Feed out	1019.6	11.3	100.17	0.1	9.6	18.2	27.88	148.0	257,520.1	223,606.0	0.09	0.1	11.7	0.3	0.2	
7/15/20 16:00	118.0	400.5	370.25	Feed out	1017.9	11.3	100.17	0.0	9.2	17.4	29.56	147.6	273,016.3	237,218.7	0.03	0.0	11.2	0.1	0.1	
7/15/20 17:00	118.2	431.0	467.95	Feed out	1055.2	11.3	100.17	0	8.8	17.1	28.22	149.1	260,629.1	225,890.2	0	0	10.6	0	0	
7/15/20 18:00	118.3	412.4	479.67	Feed out	1115.5	11.3	100.17	0	8.9	16.5	27.97	148.9	258,323.8	223,984.1	0	0	10.6	0	0	
7/15/20 19:00	118.7	430.6	258.58	Feed out	1077.9	11.3	100.17	0	9.7	15.5	27.83	147.6	257,063.3	223,377.9	0	0	11.5	0	0	
7/15/20 20:00	118.9	408.6	271.41	Feed out	1016.5	11.3	100.17	0	9.7	15.1	28.10	147.6	259,503.8	225,501.2	0	0	11.5	0	0	
7/15/20 21:00	119.0	424.1	306.24	Feed out	1021.3	11.3	100.17	0	9.6	18.4	28.31	147.7	261,500.9	227,168.3	0	0	11.8	0	0	
7/15/20 22:00	118.9	417.1	291.40	Feed out	1029.2	11.3	100.17	0	9.7	20.6	28.20	147.5	260,499.6	226,390.7	0	0	12.2	0	0	
7/15/20 23:00	119.1	438.5	264.48	Feed out	1011.3	11.3	100.16	0	9.9	19.0	28.12	147.0	259,737.5	225,909.3	0	0	12.2	0	0	
7/16/20 00:00	119.0	421.8	365.80	Feed out	1028.9	11.3	100.16	0	9.4	19.4	28.25	147.6	260,902.1	226,703.7	0	0	11.6	0	0	
7/16/20 01:00	118.9	443.0	321.83	Feed out	1089.1	11.3	100.16	0	9.5	20.9	28.13	147.4	259,838.1	225,870.5	0	0	12.0	0	0	
7/16/20 02:00	118.9	436.6	245.39	Feed out	1037.9	11.3	100.16	0	9.9	19.3	28.01	147.0	258,671.4	225,004.3	0	0	12.3	0	0	
7/16/20 03:00	118.9	442.7	272.05	Feed out	1002.5	11.3	100.17	0	9.9	16.1	28.02	146.8	258,762.4	225,133.2	0	0	11.7	0	0	
7/16/20 04:00	118.9	464.0	288.76	Feed out	1004.4	11.3	100.17	0	9.7	15.8	28.36	147.2	261,936.2	227,765.2	0	0	11.6	0	0	Begin fresh feed to FCCU
7/16/20 05:00	119.1	424.6	216.98	Feed out	981.3	11.3	100.16	0	10.0	17.6	28.53	147.1	263,486.7	229,121.2	0	0	12.1	0	0	
7/16/20 06:00	119.2	436.7	310.40	Feed out	965.5	11.3	100.16	0	9.7	18.1	28.30	147.1	261,384.1	227,326.9	0	0	11.8	0	0	
7/16/20 07:00	119.2	452.9	322.35	Feed out	1001.8	11.3	100.16	0	9.8	16.3	28.45	147.1	262,764.2	228,526.9	0	0	11.7	0	0	
7/16/20 08:00	119.0	447.8	330.16	Feed out	1039.0	11.3	100.16	12.9	8.7	15.5	28.30	147.2	261,393.7	227,265.3	12.83	15.3	10.3	30.3	20.2	CEMS daily validation
7/16/20 09:00	118.9	466.2	284.39	Feed out	1017.2	11.3	100.17	0	9.8	16.6	28.16	147.1	260,097.5	226,182.8	0	0	11.8	0	0	
7/16/20 10:00	118.9	432.6	350.35	Feed out	1033.7	11.3	100.17	0	9.5	16.1	28.29	147.7	261,283.7	226,997.3	0	0	11.3	0	0	Reintroduce, and then cut, fresh feed
7/16/20 11:00	118.8	453.6	339.07	Feed out	1077.0	11.3	100.17	0	9.5	16.1	28.30	148.2	261,368.1	226,892.9	0	0	11.3	0	0	
7/16/20 12:00	118.6	433.5	299.92	Feed out	1082.4	10.8	100.17	0	9.7	16.7	28.32	148.2	261,560.5	227,056.6	0	0	11.6	0	0	
7/16/20 13:00	118.5	447.2	205.33	Feed out	1010.6	11.3	100.17	0	10.0	17.8	29.32	147.3	270,804.7	235,432.2	0	0	12.2	0	0	
7/16/20 14:00	118.5	448.7	220.15	Feed out	948.4	11.3	100.17	0	9.8	19.8	26.78	149.4	247,313.9	214,270.4	0	0	12.3	0	0	

Electronic Filing: Received, Clerk's Office 03/15/2024 P.C. #15

Table A1-2

Hourly Average Data Associated with Startup Following 2020 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*	*BPD*	*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
7/16/20 15:00	118.4	435.2	262.25	Feed out	927.8	11.3	100.17	0	9.9	19.0	27.41	148.1	253,203.4	219,832.2	0	0	12.2	0	0	
7/16/20 16:00	118.4	422.9	355.14	Feed out	999.3	11.3	100.17	0	9.6	19.4	27.53	148.0	254,317.4	220,849.3	0	0	11.9	0	0	
7/16/20 17:00	118.2	436.7	335.81	Feed out	1044.1	11.3	100.17	0	9.7	19.4	27.47	147.8	253,682.1	220,342.8	0	0	12.0	0	0	
7/16/20 18:00	118.4	433.5	322.47	Feed out	1066.6	11.3	100.17	0	9.7	20.3	27.44	148.0	253,434.1	220,080.8	0	0	12.2	0	0	
7/16/20 19:00	118.5	414.1	291.66	Feed out	1064.1	11.3	100.17	0	9.8	19.2	27.46	147.6	253,605.0	220,369.3	0	0	12.2	0	0	
7/16/20 20:00	118.7	540.5	301.37	Feed out	1030.3	11.3	100.17	0	9.8	18.8	27.27	147.3	251,853.6	218,957.7	0	0	12.0	0	0	
7/16/20 21:00	118.9	718.2	342.99	Feed out	1092.2	11.3	100.17	0	9.5	18.4	27.98	147.8	258,449.1	224,488.2	0	0	11.6	0	0	
7/16/20 22:00	119.2	734.7	303.14	Feed out	1112.1	11.3	100.17	0	9.7	19.8	28.77	148.0	265,714.4	230,728.8	0	0	12.0	0	0	
7/16/20 23:00	119.2	725.8	280.96	Feed out	1095.4	11.3	100.17	0	10.0	18.8	29.17	147.6	269,414.5	234,114.9	0	0	12.3	0	0	
7/17/20 00:00	119.3	717.4	264.37	Feed out	1065.3	11.3	100.17	0	10.0	18.8	29.04	147.3	268,185.6	233,165.2	0	0	12.3	0	0	
7/17/20 01:00	119.4	718.7	288.04	Feed out	1026.9	11.3	100.17	0	9.8	18.8	28.85	147.3	266,433.0	231,622.6	0	0	12.1	0	0	
7/17/20 02:00	119.5	724.9	336.61	Feed out	1015.2	11.3	100.17	0	9.8	19.1	28.89	147.5	266,802.2	231,865.5	0	0	12.1	0	0	
7/17/20 03:00	119.6	727.7	447.52	Feed out	1050.8	11.3	100.17	0	9.4	19.7	29.19	147.8	269,605.6	234,208.0	0	0	11.7	0	0	
7/17/20 04:00	119.7	717.1	431.75		1102.6	11.3	100.17	0	9.4	19.9	28.95	147.6	267,378.1	232,347.4	0	0	11.7	0	0	Reintroduce fresh feed
7/17/20 05:00	119.7	722.2	402.49	Feed in, low rate	1079.9	11.3	100.17	0	9.5	20.0	29.19	147.6	269,578.1	234,232.8	0	0	11.9	0	0	
7/17/20 06:00	119.7	702.4	368.57		1063.5	11.3	100.17	0	9.6	19.8	29.39	147.8	271,488.4	235,827.8	0	0	11.9	0	0	
7/17/20 07:00	119.6	734.3	475.06		1094.6	11.3	100.17	0	9.5	17.9	28.95	147.5	267,407.8	232,383.3	0	0	11.5	0	0	Cut fresh feed
7/17/20 08:00	119.2	734.0	510.19	Feed out	1189.8	11.3	100.17	13.1	8.0	17.5	25.15	148.1	232,295.6	201,690.9	11.50	15.8	9.7	29.6	19.7	CEMS daily validation
7/17/20 09:00	118.9	725.5	424.10	Feed out	1209.0	11.3	100.17	0	9.3	16.7	26.72	148.1	246,803.2	214,282.0	0	0	11.1	0	0	
7/17/20 10:00	118.7	726.7	420.17	Feed in, low rate	1217.4	11.3	100.17	0	9.2	16.8	27.26	148.0	251,788.9	218,631.0	0	0	11.1	0	0	Reintroduce, then cut fresh feed
7/17/20 11:00	118.6	732.9	347.21	Feed out	1224.7	11.3	100.17	0	9.4	16.9	28.42	149.1	262,465.5	227,510.0	0	0	11.4	0	0	
7/17/20 12:00	118.4	720.3	375.21	Feed out	1226.4	11.3	100.17	0	9.4	17.4	28.58	149.1	263,941.9	228,798.2	0	0	11.4	0	0	
7/17/20 13:00	118.1	731.2	294.24	Feed out	1119.0	11.3	100.17	0	9.8	17.3	28.33	148.7	261,623.8	226,902.2	0	0	11.8	0	0	
7/17/20 14:00	118.0	722.8	406.53	Feed out	1084.7	11.3	100.17	0.1	9.4	18.8	28.24	148.8	260,796.6	226,172.9	0.05	0.1	11.6	0.1	0.1	
7/17/20 15:00	117.9	737.8	701.02	Feed in, low rate	1109.7	11.2	100.17	1.4	7.8	21.0	28.36	150.5	261,937.1	226,505.5	1.39	1.8	9.9	3.4	2.3	Reintroduce fresh feed
7/17/20 16:00	117.9	726.8	499.31	Feed in, ramping up	1306.3	6.6	100.17	1.9	5.5	23.2	55.77	151.1	515,063.0	444,972.3	3.68	2.5	7.2	3.8	2.5	
7/17/20 17:00	117.8	730.0	21.95		1333.2	4.8	100.17	1.8	4.8	23.5	66.15	150.7	610,995.2	528,243.3	4.11	2.3	6.3	3.3	2.2	
7/17/20 18:00	119.4	725.9	0		1341.0	4.7	100.17	2.5	4.9	23.6	79.20	150.7	731,488.5	632,358.5	6.77	3.2	6.4	4.6	3.1	
7/17/20 19:00	120.0	744.2	0	Nominal normal operating rate	1360.7	3.5	100.17	3.1	4.4	23.0	66.65	151.1	615,623.2	531,854.4	7.30	4.1	5.8	5.6	3.8	End startup (19:59). Nominal stable feed rate.
7/17/20 20:00	120.0	0	0		1351.3	3.4	100.17	1.6	4.2	22.0	67.17	150.8	620,380.5	536,264.4	3.67	2.0	5.4	2.7	1.8	
7/17/20 21:00	120.0	0	0		1358.8	3.5	100.17	0.5	4.2	21.3	67.67	150.6	625,014.7	540,425.7	1.11	0.6	5.4	0.8	0.5	
7/17/20 22:00	120.0	0	0		1362.7	3.7	100.17	0.1	4.2	21.1	71.92	150.7	664,266.5	574,228.2	0.14	0.1	5.3	0.1	0.1	
7/17/20 23:00	120.0	0	0		1360.7	3.9	100.17	0	4.1	21.7	51.74	151.1	477,913.8	412,919.2	0	0	5.3	0	0	

Electronic Filing: Received, Clerk's Office 03/15/2024 P.C. #15

Table A1-2

Hourly Average Data Associated with Startup Following 2020 Turnaround at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*	*BPD*	*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
During Hot standby/startup																				
Total															1043.40					
Average															9.66	11.04	11.50	24.48	16.32	
Maximum															274.34	328.96	12.59	643.74	429.16	
Standard Deviation															27.41	32.72	1.15	65.35	43.57	
Average + 2 SD															64.47	76.48	13.80	155.18	103.45	
Post startup																				
Total															4.93					
Average															1.23	0.67	5.35	0.91	0.60	
Maximum															3.67	2.01	5.44	2.72	1.81	
Standard Deviation															1.70	0.93	0.08	1.26	0.84	
Average + 2 SD															4.64	2.54	5.51	3.43	2.29	

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
Date/Time	*Main Air Blower*	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
	mcfm	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
11/7/23 00:00	122.8	0	0	Nominal normal operating rate	1349.5	2.2	100.07	0	2.7	14.9	32.16	148.1	297,006.5	257,876.5	0	0	3.1	0	0	
11/7/23 01:00	122.2	0	0		1354.0	2.0	100.07	0	2.6	14.1	31.87	147.9	294,326.8	255,623.6	0	0	3.0	0	0	
11/7/23 02:00	122.1	0	0		1356.3	2.2	100.07	0	2.5	13.7	31.72	147.7	292,955.8	254,511.0	0	0	2.9	0	0	
11/7/23 03:00	121.7	0	0		1358.9	2.1	100.07	0	2.4	13.8	31.48	147.5	290,756.2	252,688.5	0	0	2.8	0	0	
11/7/23 04:00	121.3	0	0		1358.6	2.1	100.06	0	2.7	17.0	31.95	147.2	295,098.2	256,587.0	0	0	3.3	0	0	
11/7/23 05:00	121.7	0	0		1358.5	2.1	100.05	0	2.8	16.0	31.96	146.9	295,160.7	256,747.8	0	0	3.3	0	0	
11/7/23 06:00	121.5	0	0		1356.9	2.1	100.05	0	2.9	16.5	32.01	146.9	295,608.6	257,146.5	0	0	3.4	0	0	
11/7/23 07:00	121.0	0	0	Cutting feed	1358.7	1.4	98.43	11.6	3.1	15.3	31.55	147.2	291,370.6	253,341.5	12.77	13.6	3.7	16.5	11.0	CEMS daily validation. Begin cutting feed, diverting out of CO Boiler
11/7/23 08:00	120.8	0	492.43		1231.3	11.2	90.68	6.7	9.8	13.2	31.69	143.8	292,729.4	255,960.7	7.44	7.7	11.3	16.7	11.1	CEMS daily validation. Begin torch oil, feed out, resume diverting back to CO Boiler
11/7/23 09:00	120.8	0	492.35		1242.1	11.2	100.17	0	9.7	13.0	31.16	142.6	287,764.6	252,116.2	0	0	11.1	0	0	Fully diverted to CO Boiler.
11/7/23 10:00	120.8	0	444.52		1241.7	11.2	100.17	0	9.5	12.2	29.47	143.1	272,182.4	238,255.6	0	0	10.8	0	0	
11/7/23 11:00	120.6	0	582.68	Feed out	1190.9	11.2	100.17	0	9.5	11.4	29.16	143.7	269,372.2	235,572.0	0	0	10.8	0	0	
11/7/23 12:00	120.0	0	476.26	Feed out	1255.3	11.2	100.17	0	10.0	11.2	29.01	143.6	267,903.4	234,343.7	0	0	11.3	0	0	
11/7/23 13:00	120.0	0	476.48	Feed out	1244.3	11.2	100.17	0	10.0	10.7	28.85	144.0	266,499.9	232,952.2	0	0	11.2	0	0	
11/7/23 14:00	120.0	0	438.82	Feed out	1222.0	10.9	100.16	0	10.0	11.4	29.09	143.8	268,711.3	234,941.9	0	0	11.3	0	0	
11/7/23 15:00	120.2	0	494.54	Feed out	1191.0	11.2	100.15	0	9.8	12.1	29.02	144.1	268,021.2	234,233.2	0	0	11.1	0	0	
11/7/23 16:00	120.2	0	488.97	Feed out	1219.0	11.2	100.13	0	9.8	13.3	29.72	146.5	274,489.4	238,960.9	0	0	11.4	0	0	
11/7/23 17:00	120.5	0	426.53	Feed out	1187.4	11.2	100.13	0	10.0	13.0	29.17	144.4	269,438.7	235,374.8	0	0	11.5	0	0	
11/7/23 18:00	120.9	0	543.24	Feed out	1197.9	11.2	100.12	0	9.9	12.2	29.07	143.9	268,466.5	234,691.7	0	0	11.2	0	0	
11/7/23 19:00	120.9	0	451.27	Feed out	1212.5	11.2	100.11	0	10.0	12.6	29.01	142.8	267,902.0	234,650.9	0	0	11.4	0	0	
11/7/23 20:00	121.0	0	632.03	Feed out	1220.6	11.2	100.10	0	9.4	12.0	29.21	143.4	269,784.6	236,072.1	0	0	10.7	0	0	
11/7/23 21:00	121.0	0	508.17	Feed out	1267.8	11.2	100.10	0	9.7	12.5	29.24	143.1	270,098.3	236,431.9	0	0	11.1	0	0	
11/7/23 22:00	121.0	0	540.04	Feed out	1237.2	11.2	100.10	0	9.9	12.3	29.49	143.0	272,381.2	238,490.5	0	0	11.2	0	0	
11/7/23 23:00	120.9	0	426.72	Feed out	1249.2	11.2	100.10	0	9.9	11.6	29.65	143.0	273,890.0	239,810.9	0	0	11.2	0	0	
11/8/23 00:00	120.8	0	536.60	Feed out	1201.0	11.2	100.10	0	9.8	14.4	30.19	144.8	278,889.0	243,461.0	0	0	11.5	0	0	
11/8/23 01:00	120.7	0	514.31	Feed out	1250.3	11.2	100.11	0	9.7	14.4	29.77	144.1	274,983.5	240,321.9	0	0	11.3	0	0	
11/8/23 02:00	120.8	0	440.31	Feed out	1181.7	11.2	100.12	0	10.0	12.4	29.47	142.1	272,201.5	238,702.3	0	0	11.4	0	0	
11/8/23 03:00	120.8	0	476.00	Feed out	1132.4	11.2	100.13	0	10.0	13.9	29.37	142.1	271,246.8	237,854.4	0	0	11.6	0	0	
11/8/23 04:00	120.8	0	467.53	Feed out	1114.3	11.2	100.13	0	10.0	14.0	29.28	141.8	270,405.5	237,230.9	0	0	11.6	0	0	
11/8/23 05:00	120.8	0	499.76	Feed out	1129.4	11.2	100.14	0	10.0	13.8	29.33	141.9	270,934.2	237,635.0	0	0	11.6	0	0	
11/8/23 06:00	120.8	0	527.66	Feed out	1196.4	11.2	100.14	0	9.9	13.0	29.40	142.2	271,535.5	238,075.0	0	0	11.3	0	0	
11/8/23 07:00	120.7	0	550.68	Feed out	1235.4	11.2	100.14	11.6	8.7	12.9	29.96	142.2	276,703.0	242,606.1	12.23	13.3	9.9	25.3	16.9	CEMS daily validation
11/8/23 08:00	120.4	0	316.93	Feed out	1172.9	10.7	100.13	0	10.0	12.6	31.53	144.2	291,224.3	254,482.0	0	0	11.4	0	0	
11/8/23 09:00	120.1	0	491.62	Feed out	1046.6	11.2	100.14	0	10.0	13.3	31.01	142.5	286,375.0	250,950.7	0	0	11.5	0	0	
11/8/23 10:00	120.5	0	512.99	Feed out	1051.1	11.2	100.15	1.1	9.8	11.9	30.95	142.2	285,820.9	250,582.1	1.23	1.3	11.1	2.7	1.8	CEMS malfunction (adjusted lamp intensity)
11/8/23 11:00	119.6	0	408.34	Feed out	1055.5	11.2	100.15	23.2	7.4	13.2	30.66	140.7	283,146.7	248,865.1	25.16	26.7	8.5	45.1	30.1	CEMS malfunction (adjusted lamp intensity)
11/8/23 12:00	119.0	0	510.70	Feed out	1072.1	11.2	100.15	11.6	8.7	12.5	30.59	141.8	282,530.9	247,878.2	12.55	13.3	9.9	25.3	16.9	CEMS malfunction (adjusted lamp intensity)

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
11/8/23 13:00	118.8	0	515.60	Feed out	1157.9	11.2	100.16	0	10.0	13.4	30.68	143.2	283,352.3	248,000.7	0	0	11.5	0	0	
11/8/23 14:00	118.9	0	364.82	Feed out	1117.4	11.2	100.17	0	10.0	13.6	30.51	143.0	281,779.9	246,705.7	0	0	11.6	0	0	
11/8/23 15:00	119.2	0	514.41	Feed out	1057.6	11.2	100.17	0	9.9	15.0	30.79	143.4	284,344.9	248,794.7	0	0	11.7	0	0	
11/8/23 16:00	119.1	0	463.93	Feed out	1074.5	11.2	100.16	0	10.0	14.2	31.63	145.1	292,111.3	254,881.7	0	0	11.6	0	0	
11/8/23 17:00	119.2	0	402.56	Feed out	1051.7	11.2	100.14	0	10.0	13.4	30.78	142.4	284,325.4	249,181.0	0	0	11.5	0	0	
11/8/23 18:00	119.2	0	486.87	Feed out	1039.7	11.2	100.13	0	10.0	13.3	30.66	141.7	283,174.8	248,474.1	0	0	11.5	0	0	
11/8/23 19:00	119.3	0	548.31	Feed out	1134.6	11.2	100.12	0	10.0	13.2	30.47	142.1	281,430.8	246,776.1	0	0	11.5	0	0	
11/8/23 20:00	119.3	0	529.82	Feed out	1175.2	11.2	100.11	0	10.0	13.8	30.83	142.0	284,762.1	249,744.8	0	0	11.6	0	0	
11/8/23 21:00	119.4	0	503.69	Feed out	1150.3	11.2	100.11	0	10.0	14.1	30.86	141.6	285,029.9	250,135.7	0	0	11.6	0	0	
11/8/23 22:00	119.4	0	495.33	Feed out	1106.2	11.2	100.11	0	10.0	13.9	30.99	141.9	286,266.9	251,100.1	0	0	11.6	0	0	
11/8/23 23:00	120.2	0	481.98	Feed out	1079.8	11.2	100.11	0	10.0	14.3	31.54	144.2	291,341.4	254,576.6	0	0	11.7	0	0	
11/9/23 00:00	120.9	0	479.47	Feed out	1097.6	11.2	100.11	0	10.0	13.9	30.79	141.3	284,403.4	249,717.6	0	0	11.6	0	0	
11/9/23 01:00	121.4	0	535.06	Feed out	1126.6	11.2	100.11	0	10.0	12.3	30.58	141.1	282,433.8	248,080.9	0	0	11.4	0	0	
11/9/23 02:00	121.5	0	468.35	Feed out	1135.4	11.2	100.11	0	10.0	12.5	30.71	140.9	283,619.0	249,193.4	0	0	11.4	0	0	
11/9/23 03:00	121.4	0	444.57	Feed out	1070.7	11.2	100.11	0	10.0	12.4	30.77	141.9	284,221.8	249,304.1	0	0	11.4	0	0	
11/9/23 04:00	121.5	0	537.54	Feed out	1034.6	11.2	100.11	0	9.9	12.7	31.07	142.0	286,985.5	251,677.4	0	0	11.4	0	0	
11/9/23 05:00	121.6	0	528.43	Feed out	1093.0	11.2	100.11	0	10.0	11.5	31.18	141.4	288,011.8	252,821.9	0	0	11.3	0	0	
11/9/23 06:00	121.5	0	511.00	Feed out	1131.3	11.2	100.11	0	10.0	11.6	30.78	141.0	284,296.4	249,741.7	0	0	11.3	0	0	
11/9/23 07:00	121.5	0	477.14	Feed out	1117.4	11.2	100.10	15.9	8.7	11.3	30.95	140.3	285,838.7	251,372.6	17.38	17.9	9.8	33.7	22.5	CEMS daily validation
11/9/23 08:00	121.4	0	537.30	Feed out	1122.2	10.7	100.10	0	9.9	10.7	31.74	143.4	293,139.2	256,500.2	0	0	11.1	0	0	
11/9/23 09:00	121.2	0	526.64	Feed out	1142.9	11.2	100.11	0	10.0	10.1	30.90	141.0	285,402.3	250,724.9	0	0	11.1	0	0	
11/9/23 10:00	121.2	0	620.58	Feed out	1130.6	11.2	100.13	0	9.9	10.8	31.04	140.9	286,651.6	251,844.7	0	0	11.1	0	0	
11/9/23 11:00	120.9	0	693.37	Feed out	1216.1	11.2	100.13	0	9.7	12.6	30.78	140.7	284,310.9	249,868.8	0	0	11.1	0	0	
11/9/23 12:00	120.0	0	414.90	Feed out	1201.5	11.2	100.14	0	10.0	13.7	30.44	139.6	281,118.9	247,521.2	0	0	11.6	0	0	
11/9/23 13:00	119.9	0	457.21	Feed out	1124.4	11.2	100.14	0	10.0	14.4	31.01	139.5	286,435.0	252,254.3	0	0	11.7	0	0	
11/9/23 14:00	119.8	0	470.80	Feed out	1105.1	11.2	100.15	0	10.0	15.9	30.55	139.0	282,170.0	248,699.7	0	0	11.9	0	0	
11/9/23 15:00	120.0	0	447.71	Feed out	1098.0	11.2	100.15	0	10.0	14.8	30.49	138.9	281,646.5	248,273.2	0	0	11.7	0	0	
11/9/23 16:00	120.3	0	380.47	Feed out	1054.6	11.2	100.15	0	10.0	13.8	31.14	141.0	287,583.2	252,634.9	0	0	11.6	0	0	
11/9/23 17:00	120.4	0	501.76	Feed out	1090.4	11.2	100.15	0	9.8	13.0	31.06	140.4	286,876.6	252,251.7	0	0	11.2	0	0	
11/9/23 18:00	120.4	0	664.30	Feed out	1085.2	11.2	100.15	0	9.7	13.8	30.92	140.1	285,607.3	251,270.7	0	0	11.2	0	0	
11/9/23 19:00	120.4	0	495.46	Feed out	1156.1	11.2	100.15	0	9.9	12.6	30.85	139.4	284,985.1	251,019.8	0	0	11.3	0	0	
11/9/23 20:00	121.0	0	499.96	Feed out	1091.4	11.2	100.16	0	10.0	13.5	30.93	139.0	285,653.4	251,772.4	0	0	11.6	0	0	
11/9/23 21:00	121.2	0	491.15	Feed out	1100.3	11.2	100.15	0	10.0	14.4	31.04	138.9	286,674.1	252,713.1	0	0	11.7	0	0	
11/9/23 22:00	121.4	0	487.12	Feed out	1117.3	11.2	100.15	0	10.0	13.9	30.99	139.2	286,264.0	252,223.4	0	0	11.6	0	0	
11/9/23 23:00	121.4	0	449.56	Feed out	1095.7	11.2	100.15	0	10.0	15.3	31.34	141.6	289,428.9	253,994.8	0	0	11.8	0	0	
11/10/23 00:00	121.5	0	456.07	Feed out	1078.1	11.2	100.15	0	10.0	13.2	31.13	138.5	287,561.0	253,665.0	0	0	11.5	0	0	
11/10/23 01:00	121.6	0	611.82	Feed out	1110.7	11.2	100.15	0	10.0	10.7	31.02	138.7	286,514.4	252,667.9	0	0	11.2	0	0	
11/10/23 02:00	121.6	0	477.37	Feed out	1145.3	11.2	100.14	0	10.0	11.1	30.86	138.7	284,987.4	251,321.8	0	0	11.3	0	0	

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
11/10/23 03:00	121.7	0	574.33	Feed out	1108.4	11.2	100.14	0	9.9	11.2	31.20	139.0	288,145.7	253,993.6	0	0	11.2	0	0	
11/10/23 04:00	121.6	0	556.73	Feed out	1101.2	11.2	100.14	0	10.0	10.9	31.38	139.1	289,849.6	255,451.3	0	0	11.2	0	0	
11/10/23 05:00	121.6	0	592.24	Feed out	1147.8	11.2	100.14	0	10.0	10.7	31.41	139.4	290,150.7	255,573.5	0	0	11.2	0	0	
11/10/23 06:00	121.6	0	581.67	Feed out	1202.1	11.2	100.13	0	10.0	10.5	31.43	139.3	290,303.5	255,741.7	0	0	11.2	0	0	
11/10/23 07:00	121.4	0	652.46	Feed out	1239.2	11.2	100.13	15.8	8.0	11.6	31.55	139.3	291,358.7	256,658.6	17.74	17.9	9.0	31.5	21.0	CEMS daily validation
11/10/23 08:00	121.2	0	493.36	Feed out	1252.3	11.2	100.11	11.5	9.4	10.8	32.07	141.5	296,229.7	260,008.5	13.07	12.9	10.6	26.2	17.4	CEMS daily validation (reran)
11/10/23 09:00	121.1	0	479.43	Feed out	1156.6	11.2	100.10	0	10.0	11.1	31.24	139.3	288,570.6	254,235.9	0	0	11.2	0	0	
11/10/23 10:00	120.9	0	642.51	Feed out	1130.5	10.7	100.10	0	9.9	11.2	30.96	139.3	285,916.6	251,887.1	0	0	11.1	0	0	
11/10/23 11:00	120.8	0	458.95	Feed out	1166.2	11.2	100.10	0	10.0	12.3	30.93	139.0	285,634.5	251,740.8	0	0	11.3	0	0	
11/10/23 12:00	120.9	0	422.56	Feed out	1053.8	11.2	100.09	0	10.0	12.4	31.10	138.6	287,229.6	253,321.8	0	0	11.4	0	0	
11/10/23 13:00	120.9	0	517.23	Feed out	1066.6	11.2	100.10	0	10.0	12.0	31.00	138.5	286,280.4	252,521.6	0	0	11.4	0	0	
11/10/23 14:00	121.1	0	469.45	Feed out	1093.8	11.2	100.10	0	10.0	12.4	31.03	138.5	286,575.4	252,810.5	0	0	11.4	0	0	
11/10/23 15:00	121.2	0	464.89	Feed out	1045.6	11.2	100.09	0	10.0	12.8	31.05	138.6	286,765.1	252,934.8	0	0	11.5	0	0	
11/10/23 16:00	121.4	0	620.70	Feed out	1076.3	11.2	100.08	0	9.9	12.5	32.03	142.2	295,877.6	259,390.4	0	0	11.3	0	0	
11/10/23 17:00	121.5	0	627.82	Feed out	1146.5	11.2	100.08	0	10.0	10.8	31.15	139.5	287,713.9	253,366.2	0	0	11.2	0	0	
11/10/23 18:00	121.5	0	649.80	Feed out	1210.6	11.2	100.08	0	10.0	10.6	31.01	138.9	286,444.3	252,498.6	0	0	11.2	0	0	
11/10/23 19:00	121.7	0	590.86	Feed out	1253.2	11.2	100.08	0	10.0	10.3	31.12	139.1	287,452.9	253,313.9	0	0	11.1	0	0	
11/10/23 20:00	121.7	0	533.13	Feed out	1212.8	11.2	100.08	0	10.0	10.4	31.19	139.1	288,063.5	253,877.8	0	0	11.2	0	0	
11/10/23 21:00	121.9	0	641.22	Feed out	1191.4	11.2	100.08	0	10.0	11.0	31.41	139.9	290,150.0	255,353.8	0	0	11.2	0	0	
11/10/23 22:00	122.1	0	636.08	Feed out	1221.4	11.2	100.08	0	10.0	10.7	31.71	139.9	292,893.3	257,785.4	0	0	11.2	0	0	
11/10/23 23:00	122.3	0	636.17	Feed out	1250.8	11.2	100.08	0	10.0	10.4	31.74	139.7	293,154.4	258,092.2	0	0	11.2	0	0	
11/11/23 00:00	122.4	0	616.79	Feed out	1269.0	11.2	100.08	0	10.0	10.8	32.53	142.4	300,475.6	263,338.3	0	0	11.2	0	0	
11/11/23 01:00	122.2	0	561.72	Feed out	1244.5	11.2	100.08	0	10.0	10.0	31.66	139.6	292,428.5	257,475.0	0	0	11.1	0	0	
11/11/23 02:00	122.2	0	611.47	Feed out	1181.8	11.2	100.08	0	10.0	10.5	31.42	139.3	290,192.9	255,657.4	0	0	11.2	0	0	
11/11/23 03:00	122.2	0	597.93	Feed out	1195.1	11.2	100.08	0	10.0	11.6	31.48	139.4	290,753.6	256,112.0	0	0	11.3	0	0	
11/11/23 04:00	122.4	0	571.37	Feed out	1185.7	11.2	100.08	0	10.0	12.9	31.55	139.4	291,370.4	256,630.0	0	0	11.5	0	0	
11/11/23 05:00	122.6	0	606.36	Feed out	1200.0	11.2	100.08	0	10.0	13.8	31.45	139.7	290,499.3	255,730.2	0	0	11.6	0	0	
11/11/23 06:00	122.8	0	529.84	Feed out	1215.7	11.2	100.08	0	10.0	13.8	31.44	139.7	290,360.6	255,608.0	0	0	11.6	0	0	
11/11/23 07:00	122.6	0	520.90	Feed out	1135.5	11.2	100.08	15.9	8.7	13.6	31.24	139.4	288,579.0	254,178.0	17.58	18.4	10.1	35.5	23.6	CEMS daily validation
11/11/23 08:00	122.4	0	570.14	Feed out	1157.1	10.7	100.08	0	9.9	13.9	31.91	142.6	294,697.0	258,180.9	0	0	11.5	0	0	
11/11/23 09:00	122.0	0	562.26	Feed out	1188.9	11.2	100.09	11.5	8.5	13.6	31.25	141.0	288,610.9	253,534.7	12.74	13.3	9.8	25.2	16.8	CEMS malfunction (O2 drifting low)
11/11/23 10:00	122.0	0	616.66	Feed out	1127.5	11.2	100.10	0	10.0	12.1	30.97	140.6	286,031.1	251,426.1	0	0	11.4	0	0	
11/11/23 11:00	122.0	0	651.54	Feed out	1189.3	11.2	100.12	0	10.0	11.8	31.04	141.2	286,724.2	251,811.0	0	0	11.3	0	0	
11/11/23 12:00	122.0	0	558.08	Feed out	1239.0	11.2	100.13	0	10.0	12.4	30.93	140.9	285,700.8	251,005.9	0	0	11.4	0	0	
11/11/23 13:00	122.1	0	592.43	Feed out	1248.6	11.2	100.15	0	10.0	11.5	30.96	141.4	285,920.3	251,006.6	0	0	11.3	0	0	
11/11/23 14:00	122.4	0	555.64	Feed out	1246.4	11.2	100.15	0	10.0	11.8	31.08	141.3	287,062.8	252,044.0	0	0	11.3	0	0	
11/11/23 15:00	122.4	0	564.00	Feed out	1238.4	11.2	100.16	0	10.0	12.6	31.00	141.1	286,327.8	251,479.8	0	0	11.4	0	0	
11/11/23 16:00	122.5	0	546.82	Feed out	1204.9	11.2	100.16	0	10.0	12.3	31.20	141.0	288,164.5	253,128.7	0	0	11.4	0	0	

Electronic Filing: Received, Clerk's Office 03/15/2024 P.C. #15

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
11/11/23 17:00	122.5	0	567.93	Feed out	1154.6	11.2	100.16	0	10.0	11.6	31.20	141.0	288,129.9	253,097.1	0	0	11.3	0	0	
11/11/23 18:00	122.4	0	595.26	Feed out	1169.8	11.2	100.15	0	10.0	11.9	31.24	141.3	288,561.9	253,346.1	0	0	11.4	0	0	
11/11/23 19:00	122.4	0	550.33	Feed out	1186.4	11.2	100.15	0	10.0	13.2	31.16	141.1	287,815.6	252,780.5	0	0	11.5	0	0	
11/11/23 20:00	122.4	0	573.97	Feed out	1169.0	11.2	100.15	0	10.0	12.3	31.18	140.9	287,988.5	253,014.6	0	0	11.4	0	0	
11/11/23 21:00	122.5	0	553.12	Feed out	1178.3	11.2	100.15	0	10.0	12.2	31.19	140.8	288,089.3	253,143.1	0	0	11.4	0	0	
11/11/23 22:00	122.3	0	609.60	Feed out	1183.7	11.2	100.15	0	10.0	11.8	31.11	141.1	287,371.9	252,392.8	0	0	11.3	0	0	
11/11/23 23:00	122.4	0	627.59	Feed out	1217.9	11.2	100.15	0	9.9	12.1	31.06	141.3	286,858.0	251,887.0	0	0	11.3	0	0	
11/12/23 00:00	122.1	0	530.09	Feed out	1205.0	11.2	100.15	0	10.0	14.1	31.91	142.8	294,774.5	258,158.3	0	0	11.6	0	0	
11/12/23 01:00	122.3	0	525.52	Feed out	1172.1	11.2	100.15	0	10.0	12.8	31.04	141.4	286,703.0	251,702.0	0	0	11.5	0	0	
11/12/23 02:00	122.2	0	577.80	Feed out	1159.8	11.2	100.15	0	10.0	12.4	31.00	140.6	286,319.9	251,690.7	0	0	11.4	0	0	
11/12/23 03:00	122.2	0	578.50	Feed out	1177.2	11.2	100.15	0	10.0	12.4	30.88	140.7	285,258.9	250,713.1	0	0	11.4	0	0	
11/12/23 04:00	122.2	0	590.43	Feed out	1171.8	11.2	100.15	0	10.0	13.9	31.20	140.6	288,129.0	253,279.2	0	0	11.6	0	0	
11/12/23 05:00	122.3	0	564.56	Feed out	1194.1	11.2	100.15	0	10.0	13.1	31.11	140.6	287,375.0	252,626.9	0	0	11.5	0	0	
11/12/23 06:00	122.3	0	533.42	Feed out	1186.9	11.2	100.14	0	10.0	12.2	30.99	140.5	286,256.0	251,673.4	0	0	11.4	0	0	
11/12/23 07:00	122.2	0	562.30	Feed out	1164.1	11.2	100.14	14.1	7.8	14.1	31.29	140.5	289,022.1	254,093.4	15.65	16.4	9.1	29.2	19.5	CEMS daily validation
11/12/23 08:00	122.2	0	650.79	Feed out	1211.1	11.2	100.14	24.4	7.7	15.5	31.95	143.2	295,075.1	258,256.1	27.53	28.9	9.1	51.3	34.2	CEMS maintenance (intermittent)
11/12/23 09:00	122.0	0	705.93	Feed out	1249.9	9.8	100.14	56.1	6.6	17.8	31.33	141.4	289,334.8	253,983.4	62.16	68.3	8.0	111.0	74.0	CEMS maintenance (intermittent)
11/12/23 10:00	121.8	0	507.93	Feed out	1231.9	11.2	100.15	11.5	8.6	18.4	30.88	140.0	285,249.5	250,995.8	12.61	14.1	10.6	28.6	19.1	CEMS maintenance (intermittent)
11/12/23 11:00	121.7	0	453.93	Feed out	1143.5	11.2	100.15	0	10.0	18.6	30.62	139.9	282,819.8	248,911.4	0	0	12.3	0	0	
11/12/23 12:00	121.9	0	472.62	Feed out	1103.9	11.2	100.16	0	10.0	19.0	30.75	140.2	283,990.3	249,823.0	0	0	12.3	0	0	
11/12/23 13:00	121.0	0	506.84	Feed out	1121.5	11.2	100.16	0	10.0	18.3	30.58	140.8	282,438.5	248,205.0	0	0	12.2	0	0	
11/12/23 14:00	120.9	0	474.62	Feed out	1124.2	11.2	100.16	0	10.0	18.4	30.57	140.5	282,330.9	248,216.9	0	0	12.2	0	0	
11/12/23 15:00	120.9	0	506.85	Feed out	1123.3	11.2	100.16	0	10.0	18.9	30.62	140.4	282,844.7	248,720.5	0	0	12.3	0	0	
11/12/23 16:00	121.0	0	430.06	Feed out	1112.0	11.2	100.17	0	10.0	18.6	31.19	142.4	288,098.9	252,480.1	0	0	12.3	0	0	
11/12/23 17:00	121.2	0	400.05	Feed out	1062.9	11.2	100.17	0	10.0	16.9	30.54	140.1	282,032.2	248,133.2	0	0	12.0	0	0	
11/12/23 18:00	121.2	0	488.84	Feed out	1017.1	11.2	100.16	0	10.0	16.1	30.46	139.9	281,291.8	247,553.8	0	0	11.9	0	0	
11/12/23 19:00	121.4	0	515.55	Feed out	1045.6	11.2	100.16	0	10.0	14.2	30.79	140.2	284,381.5	250,173.6	0	0	11.7	0	0	
11/12/23 20:00	122.1	0	503.42	Feed out	1053.7	11.2	100.16	0	10.0	14.3	30.85	139.8	284,900.7	250,775.7	0	0	11.7	0	0	
11/12/23 21:00	122.2	0	486.29	Feed out	1045.8	11.2	100.16	0	10.0	14.9	30.80	139.7	284,453.6	250,417.4	0	0	11.8	0	0	
11/12/23 22:00	122.3	0	463.26	Feed out	1048.1	11.2	100.16	0	10.0	15.1	30.90	139.4	285,446.0	251,410.4	0	0	11.8	0	0	
11/12/23 23:00	122.2	0	462.69	Feed out	1048.9	11.2	100.16	0	10.0	12.9	31.10	139.3	287,212.5	253,031.5	0	0	11.5	0	0	
11/13/23 00:00	122.2	0	519.03	Feed out	1076.0	11.2	100.15	0	10.0	12.2	31.60	141.3	291,845.5	256,241.0	0	0	11.4	0	0	
11/13/23 01:00	122.3	0	489.76	Feed out	1101.7	11.2	100.15	0	10.0	11.6	31.13	141.0	287,504.4	252,584.3	0	0	11.3	0	0	
11/13/23 02:00	122.4	0	470.01	Feed out	1089.4	11.2	100.14	0	10.0	10.9	30.86	139.7	285,059.0	250,955.6	0	0	11.2	0	0	
11/13/23 03:00	122.4	0	543.55	Feed out	1054.5	11.2	100.14	0	10.0	11.5	31.15	140.0	287,697.1	253,136.2	0	0	11.3	0	0	
11/13/23 04:00	122.4	0	520.06	Feed out	1063.3	11.2	100.13	0	10.0	11.7	31.15	139.9	287,709.8	253,186.8	0	0	11.3	0	0	
11/13/23 05:00	122.3	0	499.50	Feed out	1066.2	11.2	100.12	0	10.0	11.2	31.04	139.8	286,677.4	252,341.5	0	0	11.3	0	0	
11/13/23 06:00	122.3	0	472.08	Feed out	1075.8	11.2	100.12	0	10.0	10.9	31.00	139.8	286,312.9	252,030.7	0	0	11.2	0	0	

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
11/13/23 07:00	122.4	0	479.01	Feed out	1046.7	11.2	100.12	11.5	8.6	11.0	31.34	139.8	289,463.7	254,795.7	12.80	13.0	9.7	24.1	16.1	CEMS daily validation
11/13/23 08:00	122.1	0	595.13	Feed out	1118.1	11.2	100.12	0	9.7	11.2	31.41	141.6	290,092.6	254,576.6	0	0	11.0	0	0	
11/13/23 09:00	121.9	0	449.85	Feed out	1141.7	10.4	100.11	0	9.8	11.2	31.38	144.7	289,864.3	253,058.1	0	0	11.1	0	0	
11/13/23 10:00	121.4	0	480.92	Feed out	1090.2	11.2	100.12	0	10.0	10.4	30.49	142.7	281,625.5	246,720.1	0	0	11.2	0	0	
11/13/23 11:00	121.0	0	613.12	Feed out	1113.3	11.2	100.13	0	9.9	11.7	30.51	143.3	281,777.8	246,597.5	0	0	11.2	0	0	
11/13/23 12:00	120.6	0	520.86	Feed out	1159.4	11.2	100.13	0	9.9	12.6	30.51	142.6	281,796.9	246,891.2	0	0	11.3	0	0	
11/13/23 13:00	120.5	0	387.53	Feed out	1060.5	11.2	100.13	0	10.0	12.2	30.59	141.9	282,570.3	247,865.5	0	0	11.4	0	0	
11/13/23 14:00	120.4	0	443.81	Feed out	1023.8	11.2	100.13	0	10.0	11.9	30.51	141.5	281,763.3	247,298.9	0	0	11.4	0	0	
11/13/23 15:00	120.6	0	550.58	Feed out	1049.1	11.2	100.13	0	10.0	12.1	30.39	141.9	280,656.3	246,158.7	0	0	11.4	0	0	
11/13/23 16:00	120.6	0	460.56	Feed out	1089.7	11.2	100.13	0	10.0	12.6	31.20	143.5	288,139.9	252,080.4	0	0	11.4	0	0	
11/13/23 17:00	121.2	0	396.64	Feed out	1041.4	11.2	100.13	0	10.0	11.1	30.40	140.3	280,793.9	246,962.1	0	0	11.3	0	0	
11/13/23 18:00	121.4	0	496.98	Feed out	1043.1	11.2	100.13	0	10.0	12.0	30.59	139.8	282,544.2	248,706.9	0	0	11.4	0	0	
11/13/23 19:00	121.7	0	457.68	Feed out	1061.6	11.2	100.13	0	10.0	11.8	30.91	139.6	285,524.2	251,427.1	0	0	11.3	0	0	
11/13/23 20:00	121.8	0	483.12	Feed out	1026.8	11.2	100.13	0	10.0	11.5	30.94	139.8	285,744.1	251,530.9	0	0	11.3	0	0	
11/13/23 21:00	122.7	0	506.34	Feed out	1034.8	11.2	100.13	0	10.0	11.3	30.87	139.7	285,147.8	251,035.9	0	0	11.3	0	0	
11/13/23 22:00	122.8	0	484.92	Feed out	1023.9	11.2	100.12	0	10.0	11.6	31.07	139.3	286,990.0	252,838.6	0	0	11.3	0	0	
11/13/23 23:00	122.8	0	555.61	Feed out	1070.6	11.2	100.13	0	10.0	12.4	31.03	139.9	286,622.8	252,257.1	0	0	11.4	0	0	
11/14/23 00:00	122.7	0	468.40	Feed out	1092.0	11.2	100.12	0	10.0	14.7	31.52	139.9	291,172.1	256,272.5	0	0	11.7	0	0	
11/14/23 01:00	122.6	0	499.28	Feed out	1052.3	11.2	100.12	0	10.0	15.3	32.03	142.2	295,853.9	259,377.7	0	0	11.8	0	0	
11/14/23 02:00	122.5	0	586.02	Feed out	1106.1	11.2	100.12	0	10.0	14.7	31.38	139.9	289,858.0	255,092.1	0	0	11.7	0	0	
11/14/23 03:00	122.6	0	580.62	Feed out	1087.8	11.2	100.12	0	10.0	14.7	31.36	139.8	289,647.7	254,949.6	0	0	11.7	0	0	
11/14/23 04:00	122.7	0	610.82	Feed out	1083.2	11.2	100.11	0	9.9	14.9	31.51	140.2	290,989.5	255,950.3	0	0	11.6	0	0	
11/14/23 05:00	122.6	0	595.18	Feed out	1080.7	11.2	100.11	0	9.9	14.4	31.42	140.5	290,159.4	255,127.3	0	0	11.6	0	0	
11/14/23 06:00	122.7	0	582.13	Feed out	1107.5	11.2	100.11	0	9.9	12.9	31.01	140.4	286,376.3	251,841.0	0	0	11.4	0	0	
11/14/23 07:00	122.4	0	872.73	Feed out	1187.5	11.2	100.11	11.5	8.2	12.9	31.70	141.3	292,826.7	257,089.6	12.94	13.2	9.5	24.2	16.1	CEMS daily validation
11/14/23 08:00	122.1	0	632.60	Feed in, ramping up	1267.8	10.3	100.11	0	8.0	13.8	31.89	142.0	294,569.6	258,349.5	0	0	9.2	0	0	Begin Fresh Feed to FCCU
11/14/23 09:00	121.9	0	196.12		1328.8	7.9	100.12	0	5.9	17.1	32.16	143.4	297,077.2	259,930.8	0	0	7.1	0	0	Increase FCCU Fresh Feed, begin cutting Torch Oil
11/14/23 10:00	121.0	0	26.88		1344.2	6.4	100.14	0	5.2	19.1	31.89	144.4	294,574.1	257,315.2	0	0	6.5	0	0	Continue cutting Torch Oil
11/14/23 11:00	120.6	0	0		1368.6	4.0	100.16	0	4.2	21.4	31.49	145.0	290,875.5	253,852.2	0	0	5.3	0	0	Torch Oil out. End Hot Standby
11/14/23 12:00	120.6	0	0		1397.4	2.4	100.17	0	3.5	21.0	31.26	145.6	288,717.1	251,721.8	0	0	4.5	0	0	
11/14/23 13:00	120.7	0	0	Nominal normal operating rate	1403.3	1.8	100.17	0	3.1	19.8	31.90	145.9	294,599.4	256,707.2	0	0	3.9	0	0	
11/14/23 14:00	121.0	0	0		1408.0	2.0	100.17	0	3.1	19.7	32.16	145.5	297,059.9	258,998.2	0	0	3.9	0	0	
11/14/23 15:00	121.3	0	0		1412.7	1.7	100.17	0	3.0	18.4	32.30	145.9	298,348.4	259,981.2	0	0	3.7	0	0	
11/14/23 16:00	121.5	0	0		1402.7	2.1	100.17	0	3.3	18.1	33.13	147.4	305,970.6	265,952.3	0	0	4.0	0	0	
11/14/23 17:00	121.6	0	0		1402.7	2.0	100.17	0	3.3	20.1	32.84	146.2	303,355.1	264,190.7	0	0	4.1	0	0	
11/14/23 18:00	121.7	0	0		1400.4	2.1	100.17	0	3.4	19.5	32.72	145.3	302,249.0	263,617.1	0	0	4.2	0	0	
11/14/23 19:00	121.7	0	0		1400.8	2.0	100.17	0	3.4	20.6	32.72	145.4	302,250.6	263,594.3	0	0	4.3	0	0	
11/14/23 20:00	121.7	0	0		1402.8	2.1	100.17	0	3.5	18.9	32.69	145.3	301,913.4	263,345.3	0	0	4.3	0	0	

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	
Date/Time	*mcfm*	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	*Note*
11/14/23 21:00	121.8	0	0		1402.5	1.9	100.17	0	3.4	16.3	32.87	146.4	303,600.5	264,330.9	0	0	4.1	0	0	
11/14/23 22:00	122.9	0	0		1404.4	2.0	100.16	0	3.4	15.3	32.79	146.4	302,860.8	263,672.6	0	0	4.0	0	0	
11/14/23 23:00	122.9	0	0		1403.9	2.0	100.15	0	3.4	16.3	32.87	146.0	303,605.6	264,498.0	0	0	4.1	0	0	

Table A2

Hourly Average Data Associated with November 2023 Hot Standby Event Not Associated with Startup at CITGO Lemont Refinery FCCU

	Key process information							*Monitored Stack Information*					*Calculated information*							
	Main Air Blower	*Air Heater*	*Torch Oil*	*Fresh Feed*	*Regenerator T*	*Regenerator O2*	*Diverter valve position*	*STACK CO*	*STACK O2*	*STACK H2O*	*STACK VELOCITY*	*STACK TEMP*	*Actual stack flow (Q)*	*Stack flow at standard T (Qs)*	*CO Mass Emission Rate*	*[CO]d*	*[O2]d*	*[CO]d, 0% O2*	*[CO]d, 50% EA*	*Note*
Date/Time	*mcfm*	*mcfd*	*BPD*		*F*	*% vol (wet)*	*% closed (% diverted to CO Boiler)*	*PPM*	*PCT*	*PCT*	*FT/SEC*	*DEGF*	*acfm (w)*	*scfm (w)*	*lbs./hr.*	*ppmv, d*	*% vol, d*	*ppmvd, 0% O2*	*ppmvd, 50% EA*	
Pre-Hot Standby																				
Total															12.77	lbs., includes CEMS maintenance				
Average															1.60	1.70	3.21	2.07	1.38	
Maximum															12.77	13.64	3.67	16.54	11.03	
Avg. if w/o CEMS work															0.00	0.00	3.14	0.00	0.00	
Max if w/o CEMS work															0.00	0.00	3.44	0.00	0.00	
Standard Deviation															4.51	4.82	0.29	5.85	3.90	
Average + 2 SD															10.62	11.35	3.78	13.76	9.18	
During Hot Standby																				
Total															280.81	lbs., includes CEMS maintenance				
Average															1.64	1.73	11.20	3.13	2.09	
Maximum															62.16	68.29	12.34	110.98	73.99	
Avg. if w/o CEMS work															0.00	0.00	11.35	0.00	0.00	
Max if w/o CEMS work															0.00	0.00	12.34	0.00	0.00	
Standard Deviation															6.49	6.96	0.79	11.98	7.99	
Average + 2 SD															14.61	15.66	12.79	27.10	18.07	
Post Hot Standby																				
Total															0.00					
Average															0.00	0.00	4.19	0.00	0.00	
Maximum															0.00	0.00	5.35	0.00	0.00	
Avg. if w/o CEMS work															0.00	0.00	5.35	0.00	0.00	
Max if w/o CEMS work															0.00	0.00	5.35	0.00	0.00	
Standard Deviation															0.00	0.00	0.41	0.00	0.00	
Average + 2 SD															0.00	0.00	5.00	0.00	0.00	

Table A3

Summary of FCCU Startups, Not Including Startups w/ Refractory Dryout and Not Associated with CO Boiler Trips

Trip	*Startup*			*Event Duration (hrs.)*	*Total Event Mass CO (lbs.)*	*Relative to 35 IAC 216.361(a)*				*Relative to 35 IAC 216.361(b)*		*Note*	*Maximum hourly emission rate (lbs./hr.)*	*Maximum [CO]d, @ 50% EA (ppmvd, @ 50% EA)*	*Date/Time of Max*	*Regenerator T at max CO (°F)*	*Regenerator O2 at max CO (% vol, w)*
Date/Time of Trip	*Event start*	*Event End*	*Brief Description*			*Start of Excess Emissions*	*End of Excess Emissions*	*No. of hours > 200 ppmv @ 50% EA, 1-hr average*	*No. of hours > 200 ppmv @ 50% EA 3-hr average*	*No. of hours > 750 ppmv @ 50% EA, 1-hr average*	*No. of hours > 750 ppmv @ 50% EA, 3-hr average*						
10/14/2016 00:00	10/14/2016 00:37	10/16/2016 15:54	Hot standby and Startup following a unit trip when feed-pumps shut down unexpectedly due to an overspeed trip rod becoming disengaged, causing the pump to shut down and associated feed valves to close. CO Boiler was bypassed and continued to operate while FCCU was restored.	63.28	4,154.37	10/14/2016 00:00	10/14/2016 17:00	9	12	3	1	Diverting to CO Boiler	711.7	1,203.8	10/14/2016 01:00	755.5	8.42
11/30/2018 21:08	11/30/2018 21:48	12/1/2018 02:47	Startup, following an unplanned unit shutdown due to regenerator slide valve problems. Main air blower continued to run, CO Boiler was bypassed and continued to operate while FCCU operation was restored.	4.98	523.80	11/30/2018 22:00	12/1/2018 00:00	2	3	0	0	Starting Torch Oil and Diverting to CO Boiler	357.0	637.4	11/30/2018 23:00	896.6	11.00
3/24/2020 00:55	3/24/2020 04:25	3/24/2020 19:13	Hot Standby and Startup following an unplanned Unit shutdown caused by an upset at the downstream Unit 212 Unsaturated Gas Plant. CO Boiler was bypassed and continued to operate while FCCU operation was restored.	14.80	585.21	3/24/2020 06:00	3/24/2020 08:00	2	3	0	0	Began Torch Oil and Diverting to CO Boiler	275.7	726.4	3/24/2020 06:00	1,006.9	10.74
2/27/2023 05:35	2/28/2023 20:00	3/2/2023 02:46	Hot Standby and Startup following a trip of the FCCU Unit due to a catalyst leak. CO Boiler was bypassed and continued to operate while leak was repaired and FCCU operation was restored.	30.77	1,127.51	3/1/2023 09:00	3/1/2023 11:00	2	3	0	0	Diverting to CO Boiler	631.4	611.5	3/1/2023 10:00	96.9	11.22
	Max.			63.28	4,154.37	10/14/2016 00:00	10/14/2016 17:00	9	12	3	1		711.7	1,203.8	10/14/2016 01:00	755.5	8.42

Table A4

Summary of FCCU Operations during CO Boiler Trips/Shutdowns (Not Associated with FCCU Maintenance Turnarounds)

				Relative to 35 IAC 216.361(a)										
Event start	*Event End*	*Brief Description*	*Event Duration (hrs.)*	*Start of Excess Emissions*	*End of Excess Emissions*	*No. of hours > 35 IAC 216.361(a) [200 ppmv @ 50% EA]*	*No. of hours > 35 IAC 216.361(b) [750 ppmv @ 50% EA]*	*Note*	*Maximum hourly emission rate (lbs./hr.)*	*Maximum [CO]d, @ 50% EA (ppmvd, @ 50% EA)*	*Date/Time of Max*	*Regenerator T at max CO (°F)*	*Regenerator O_2 at max CO (% vol, w)*
12/11/2017 19:57	12/20/2017 09:37	CO Boiler Trip for tube repairs. FCCU continued to operate in Full-Burn.	205.67	NA	NA	0	0	FCCU diverted around CO Boiler	23.3	31.5	12/16/2017 23:00	1,403.4	0.59
12/8/2018 04:02	12/21/2018 15:46	CO Boiler Trip to repair tube leak discovered 11/19/2018. FCCU continued to operate in Full-Burn.	323.73	NA	NA	0	0	FCCU diverted around CO Boiler	83.4	155.2	12/20/2018 10:00	1,383.5	1.63
5/11/2019 07:10	5/29/2019 09:20	Planned shutdown of CO Boiler to perform repairs. FCCU continued to operate in Full-Burn.	434.17	NA	NA	0	0	FCCU diverted around CO Boiler	102.9	82.6	5/23/2019 09:00	1,407.8	1.13
2/29/2020 13:58	3/9/2020 12:01	CO Boiler was tripped due to High Pressure Steam tube leak in boiler, requiring subsequent repairs. FCCU continued to operate in Full Burn.	214.05	NA	NA	0	0	FCCU diverted around CO Boiler	93.5	98.7	3/7/2020 06:00	1,414.1	1.76
8/10/2020 00:05	9/8/2020 16:15	Planned shutdown of CO Boiler to perform substantial retube of lower tubes in the Upper Steam Generator of the CO Boiler. FCCU continued to operate in Full Burn.	712.17	NA	NA	0	0	FCCU diverted around CO Boiler	88.3	132.4	9/6/2020 22:00	1,394.1	0.84
9/24/2022 02:45	10/13/2022 07:19	Shutdown of CO Boiler to perform repairs due to tube leaks in Upper Steam generator of the CO Boiler. FCCU continued to operate in Full Burn.	460.57	NA	NA	0	0	FCCU diverted around CO Boiler	16.5	41.8	9/24/2022 07:00	1,412.3	1.09
Max.									102.9	155.2	5/23/2019 09:00	1,407.8	1.13

Appendix B

Lemont Refinery FCCU Startup CO Dispersion Modeling Stack Parameter Inputs

Table B1

Potential 1-hr Average CO Dispersion Modeling Inputs

			Max ER case		*Modeling Inputs*							
Source	*Max lbs./hr.*	*Date/Time of Min/Max*	*acfm*	*T (°F)*	*CO emission rate, 1-hr avg. (g/s)*	*D (m)*	*H (m)*	*T (°K)*	*V (m/s)*	*Latitude*	*Longitude*	*Note*
FCCU	417.88	7/23/2015 14:00	313,816.70	144.5403	52.6524	4.2977	60.6552	335.6724	10.2097	41:38:42.3	88:03:14.73	
FCCU	711.74	10/14/2016 1:00	303,433.00	141.9111	89.6783	4.2977	60.6552	334.2117	9.8718	41:38:42.3	88:03:14.73	Scenario 2 (1-hr. avg.) - Emis. Rate, Temp., Vel. - Max E.R. Event
FCCU	357.00	11/30/2018 23:00	305,468.28	150.6222	44.9817	4.2977	60.6552	339.0512	9.9381	41:38:42.3	88:03:14.73	
FCCU	275.71	3/24/2020 6:00	201,939.41	139.9362	34.7394	4.2977	60.6552	333.1145	6.5699	41:38:42.3	88:03:14.73	Scenario 3 (1-hr. avg.) - Emis. Rate, Temp., Vel. - Min T, V Event
FCCU	319.30	7/14/2020 22:00	270,917.73	145.9733	40.2311	4.2977	60.6552	336.4685	8.8140	41:38:42.3	88:03:14.73	
FCCU	631.40	3/1/2023 10:00	359,469.49	143.5673	79.5551	4.2977	60.6552	335.1318	11.6949	41:38:42.3	88:03:14.73	
Max Event	711.74	10/14/2016 1:00	303,433.00	141.9111	89.6783	4.2977	60.6552	334.2117	9.8718	41:38:42.3	88:03:14.73	
Min	275.71	3/24/2020 6:00	201,939.41	139.9362	34.7394	4.2977	60.6552	333.1145	6.5699	41:38:42.3	88:03:14.73	
Average	452.17		292,507.43	144.4251	56.9730	4.2977	60.6552	335.6084	9.5164	41:38:42.3	88:03:14.73	
Std. Deviation	178.06		52,714.39	3.6884	22.4351	0.0000	0.0000	2.0491	1.7150	0:00:00.00	0:00:00.00	
Avg. + 2 Std. Dev.	808.29		397,936.22	151.8019	101.8432	4.2977	60.6552	339.7066	12.9464	41:38:42.3	88:03:14.73	Scenario 1 (1-hr. avg.) - Emis. Rate - Statistical Worst Case
Avg. - 2 Std. Dev.	96.06		187,078.65	137.0483	12.1028	4.2977	60.6552	331.5101	6.0864	41:38:42.3	88:03:14.73	Scenario 1 (1-hr avg.) - Temp., Vel. - Statistical Worst Case
Artificial Statistical worst-case scenario	808.29		187,078.65	137.0483	101.8432	4.2977	60.6552	331.5101	6.0864	41:38:42.3	88:03:14.73	Statistical Worst-case stack parameters: $ER_{Statistical\ Worst\text{-}Case}$ = Avg. + 2 SD ER $T_{Statsistical\ Worst\text{-}Case}$ = Avg. - 2 SD stack T $Q_{Statistical\ Worst\text{-}Case}$ = Avg. - 2 SD flow rate $H_{Statistical\ Worst\text{-}Case}$ = Act. (only one FCCU at Lemont Refinery) $D_{Statistical\ Worst\text{-}Case}$ = Act. (only one FCCU at Lemont Refinery) $V_{Statistical\ Worst\text{-}Case}$ = Avg - 2 SD velocity = $Q_{Avg+2SD.}/(\pi\ (D_{Act}/2)^2)$
Statistical worst-case basis	Avg. + 2 Std. Dev.		Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.	Avg. + 2 Std. Dev.	Act.	Act.	Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.			

Table B2

Potential 8-hr Average CO Dispersion Modeling Inputs

	Max 8-hr avg ER case		*Max ER case*		*Modeling Inputs*								
Source	*Max 8-hr avg. ER (lbs./hr.)*	*Date/Time of Max*	*acfm*	*T (°F)*	*CO Emission Rate, 8-hr avg. (g/s)*	*D (m)*	*H (m)*	*T (°K)*	*V (m/s)*	*Latitude*	*Longitude*	*Note*	*8-hr avg. ER as % of 1-hr avg. ER*
FCCU	79.53	7/23/2015 19:00	292,545.14	144.5064	10.0211	4.2977	60.6552	335.6536	9.5176	41:38:42.3	88:03:14.73		19.0%
FCCU	227.00	10/14/2016 8:00	251,412.97	147.3423	28.6020	4.2977	60.6552	337.2291	8.1794	41:38:42.3	88:03:14.73	Scenario 2 (8-hr. avg.) - Emis. Rate, Temp., Vel. - Max E.R. Event	31.9%
FCCU	65.50	11/30/2018 23:00	327,611.78	154.0493	8.2526	4.2977	60.6552	340.9552	10.6585	41:38:42.3	88:03:14.73		18.3%
FCCU	83.26	3/24/2020 13:00	245,297.75	139.4271	10.4908	4.2977	60.6552	332.8317	7.9805	41:38:42.3	88:03:14.73	Scenario 3 (8-hr. avg.) - Emis. Rate, Vel. - Min Vel. Event	30.2%
FCCU	54.31	7/14/2020 22:00	297,251.11	145.8294	6.8428	4.2977	60.6552	336.3886	9.6707	41:38:42.3	88:03:14.73		17.0%
FCCU	111.37	3/1/2023 10:00	404,986.01	138.9153	14.0320	4.2977	60.6552	332.5474	13.1758	41:38:42.3	88:03:14.73	Scenario 3 (8-hr. avg.) - Temp. - Min Vel. Event	17.6%
Max	227.00		404,986.01	154.0493	28.6020	4.2977	60.6552	340.9552	13.1758	41:38:42.3	88:03:14.73		31.9%
Min	54.31		245,297.75	138.9153	6.8428	4.2977	60.6552	332.5474	7.9805	41:38:42.3	88:03:14.73		19.7%
Average	103.50		303,184.13	145.0116	13.0402	4.2977	60.6552	335.9342	9.8638	41:38:42.3	88:03:14.73		22.9%
Std. Deviation	63.50		58,548.79	5.5926	8.0012	0.0000	0.0000	3.1070	1.9048	0:00:00.00	0:00:00.00		35.7%
Avg. + 2 Std. Dev.	230.50		420,281.72	156.1969	29.0426	4.2977	60.6552	342.1483	13.6734	41:38:42.3	88:03:14.73	Scenario 1 (8-hr. avg.) - Emis. Rate - Statistical Worst Case	28.5%
Avg. - 2 Std. Dev.	-23.51		186,086.54	133.8264	-2.9622	4.2977	60.6552	329.7202	6.0541	41:38:42.3	88:03:14.73	Scenario 1 (8-hr avg.) - Temp., Vel. - Statistical Worst Case	-24.5%
Artificial Statistical worst-case scenario	230.50		186,086.54	133.8264	29.0426	4.2977	60.6552	329.7202	6.0541	41:38:42.3	88:03:14.73	Statistical Worst-case stack parameters: $ER_{Statistical\ Worst\text{-}Case}$ = Avg. + 2 SD ER $T_{Statsistical\ Worst\text{-}Case}$ = Avg. - 2 SD stack T (also use for 1-hr avg.) $Q_{Statistical\ Worst\text{-}Case}$ = Avg. - 2 SD flow rate $H_{Statistical\ Worst\text{-}Case}$ = Act. (only one FCCU at Lemont Refinery) $D_{Statistical\ Worst\text{-}Case}$ = Act. (only one FCCU at Lemont Refinery) $V_{Statistical\ Worst\text{-}Case}$ = Avg - 2 SD velocity = $Q_{Avg+2SD.}/(\pi\ (D_{Act}/2)^2)$	28.5%
Statistical worst-case basis	Avg. + 2 Std. Dev.		Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.	Avg. + 2 Std. Dev.	Act.	Act.	Avg. - 2 Std. Dev.	Avg. - 2 Std. Dev.				

Appendix C

Lemont Refinery FCCU Startup CO Dispersion Modeling Report

FCCU STARTUP MODELING REPORT

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Project 231401.0192

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1. BACKGROUND

CITGO Petroleum Corporation, Inc. (CITGO) is presenting this modeling report in response to the Illinois Environmental Protection Agency's (Illinois EPA) request to model startup conditions for the Fluid Catalytic Cracking Unit (FCCU) at CITGO's site in Lemont, Illinois (Lemont Facility). This report describes the modeling procedures that were used to evaluate whether the startup conditions of this unit causes or contributes to exceedances of the Significant Impact Levels (SILs) and National Ambient Air Quality Standards (NAAQS) for Carbon Monoxide (CO) 1-hour and 8-hour.

Trinity Consultants (Trinity) has conducted the modeling analyses in a manner that conforms to the applicable rules and requirements for dispersion modeling, including the following guidance documents:

- USEPA: *Guideline on Air Quality Models,* 40 CFR Part 51 - Appendix W (Revised, January 17, 2017).
- USEPA: *AERMOD Implementation Guide* (Revised, June 2022).

The remainder of this modeling report is organized as follows:

- Section 2 discusses modeling methodology;
- Section 3 discusses modeling requirements;
- Section 4 provides a brief description of the facility; and
- Section 5 provides the model results.

2. MODELING METHODOLOGY

2.1 UTM Coordinate System

The model, the locations of emission sources, structures, and receptors were represented in Universal Transverse Mercator (UTM) NAD83, Zone 16N.

2.2 Model Selection

Trinity conducted air dispersion modeling analyses using version 23132 of the AERMOD modeling system to estimate maximum ground-level concentrations associated with the facility. AERMOD is a refined, steady-state, multiple-source, Gaussian dispersion model and was promulgated in December 2005 as the preferred model for use by industrial sources in this type of air quality analysis.

The following modeling programs were utilized for the model run:

- AERMOD 23132
- BPIP PRIME 04274
- AERMAP 18081

2.3 Meteorological Data

Model-ready meteorological data was provided by Cari Rutherford of Illinois EPA on December 5, 2023. The data covered the years 2018-2022. Surface data was taken from O'Hare International Airport in Chicago, IL while upper air data was taken from the National Weather Service Forecast Office in Davenport, IA.

2.4 Treatment of Terrain

AERMAP (v18081) is the terrain pre-processor that is used to import terrain elevations for selected model objects and to generate the receptor hill height scale data that are used by AERMOD to drive advanced terrain processing algorithms. Trinity utilized 1/3-arcsecond National Elevation Dataset (NED) data available from the United States Geological Survey (USGS) to interpolate surveyed elevations onto user-specified receptor grids, buildings, and sources in the absence of more accurate site-specific (i.e., site surveys, GPS analyses, etc.) elevation data.

2.5 Receptor Grids

In the air dispersion modeling analysis, ground-level concentrations were calculated within five Cartesian receptor grids.[1] The grids are defined as follows:

- Fence Line Receptors[2]: A grid consisting of evenly spaced receptors 50 m apart placed along the facility's ambient air boundary
- 50-meter Cartesian Grid: A grid containing 50-meter space receptors extending approximately 1 km from the fenceline

[1] Receptor grid was created following Table 10 of Minnesota Pollution Control Agency (MPCA) Air Dispersion Modeling Practices, September 2022.

[2] Fenceline receptors were set up according to Illinois EPA's guidance document "The Art and Science of the PSD Air Quality Analysis The Modeling Perspective", July 2021.

- 100-meter Cartesian Grid: A grid containing 100-meter spaced receptors extending from 1 km to 2 km from the fenceline, exclusive of the receptors in the previous grids
- 250-meter Cartesian Grid: A grid containing 250-meter spaced receptors extending from 2 km to 5 km from the fenceline, exclusive of the receptors in the previous grids
- 500-meter Cartesian Grid: A grid containing 500-meter spaced receptors extending from 5 km to 10 km from the fenceline, exclusive of the receptors in the previous grids
- 1,000-meter Cartesian Grid: A grid containing 1,000-meter space receptors extending from 10 km to 50km from the fenceline, exclusive of the receptors in the previous grids.

Figure 1 in Appendix A displays the receptor grid layout.

2.6 Background Concentrations

The background concentrations used to model the cumulative CO impacts for the 1-hour and 8-hour standards were obtained using EPA's Interactive Map of Air Quality Monitors, and the Lansing, Illinois monitor (AQS Site ID 17-031-0119) was used for this project. The Lansing monitor is located adjacent to a heavily trafficked interstate roadway, I-80/94. Due to its proximity to this roadway, it is likely that the Lansing monitor measures extensive levels of vehicle emissions. The closest expressway to the Lemont Facility is two miles away (I-355) and is not as heavily trafficked as I-80/94. The concentrations observed at the Lansing monitor are considered conservative for the Lemont Facility because of the lower levels of expected vehicle emissions at the Lemont Facility. The average ppm concentration values from 2021 to 2023 were added to the modeling results to determine the cumulative impacts.

2.7 Building Downwash

AERMOD incorporates the Plume Rise Modeling Enhancements (PRIME) downwash algorithms and the direction-specific building downwash dimensions used as inputs are determined by the Building Profile Input Program, PRIME version (BPIP PRIME), version 04274. BPIP PRIME is designed to incorporate the concepts and procedures expressed in the GEP Technical Support document, the Building Downwash Guidance document, and other related documents, while incorporating the PRIME enhancements.

The heights, locations, and dimensions of buildings located on site were obtained from facility plot plans provided by CITGO.

Figure 2 in Appendix A displays the modeled buildings, which are shown in dark blue.

3. MODELING REQUIREMENTS

The objective of this analysis is to illustrate that the FCCU operating at the Lemont Facility does not cause or contribute to an exceedance of the SILs and/or NAAQS for CO.

Trinity, on behalf of CITGO, has conducted air dispersion modeling in accordance with the Illinois EPA's modeling guidance.

3.1 Significance Analysis

The significance analysis is conducted to determine whether the emissions associated with the startup conditions of the source cause a significant impact on the area surrounding the facility. "Significant" impacts are defined by ambient concentration thresholds commonly referred to as the SILs. Table 1 includes the SIL and NAAQS for CO.

Table 1. SILs and NAAQS for CO

Pollutant	Averaging Period	SIL ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
CO	8-Hour	500	10,000
	1-Hour	2,000	40,000

This modeling analysis will be used to demonstrate compliance with the standards included in Table 1.

3.2 NAAQS Analysis

The primary NAAQS are the maximum concentration ceilings, measured in terms of total concentration of a pollutant in the atmosphere, which define the "levels of air quality that the U.S. EPA judges are necessary, with an adequate margin of safety, to protect the public health." Secondary NAAQS define the levels that "protect the public welfare from any known or anticipated adverse effects of a pollutant." The NAAQS are shown in Table 1 for CO. The objective of the NAAQS Analysis is to demonstrate through air quality modeling that emissions associated with the startup conditions of the source does not contribute to or cause an exceedance of the NAAQS at any ambient location.

4. MODELING EMISSIONS INVENTORY

4.1 Modeled Source

Table 2 below includes an inventory of the point source included in the model.

Table 2. Modeled Point Source Inventory

Model ID	Description	Source Type
FCCU	Fluid Catalytic Cracking Unit	Point

4.2 Modeled Stack Parameters

Three different scenarios were modeled for the sake of this analysis to illustrate that the startup conditions of the FCCU do not exceed the SILs and NAAQS increments. The first scenario modeled the worst-case parameters for the unit. These parameters were based upon statistically based maximum emission rate (average + 2 standard deviations) and minimum velocity and temperature (average – 2 standard deviations). Scenario 2 and Scenario 3 modeled event-specific startup parameters for the FCCU. Scenario 2 reflected parameters from the maximum emission rate startup event caused by a unit trip on October 14, 2016. The last scenario, Scenario 3, represented the startup parameters for the FCCU's minimum velocity and temperature event on March 24, 2020, caused by an unplanned unit shutdown. A review of the startup event hourly emission rates showed that no event had a constant emission rate for 8-hours, and the 8-hour average emission rates were all less than the maximum 1-hour average. Accordingly, these 8-hour averages for the events were evaluated to determine separate 8-hour average emission rate inputs for each of the 3 scenarios modeled. Tables 3 and 4 below show the parameters for each source included in each scenario's model.

Table 3. Worst Case Point Source Stack Parameters[3]

Model ID	Averaging Period	Stack Height (m)	Stack Temperature (K)	Stack Velocity[a] (m/s)	Stack Diameter (m)	Stack Airflow (acfm)	CO Emission Rate (g/s)
Scenario 1							
FCCU	1-Hr	60.6552	331.5101	6.0864	4.29768	201,939.4	101.84
FCCU	8-Hr	60.6552	329.7202	6.0541	4.29768	186,086.5	29.09

a. Stack Velocity calculated based on Stack Diameter and Stack Airflow.

[3] Parameters based on statistical worst case values.

Table 4. Actual FCCU Event Point Source Stack Parameters[4]

Model ID	Averaging Period	Stack Height (m)	Stack Temperature (K)	Stack Velocity[a] (m/s)	Stack Diameter (m)	Stack Airflow (acfm)	CO Emission Rate (g/s)
Scenario 2							
FCCU	1-Hr	60.6552	334.2117	9.8718	4.29768	303,433.0	89.68
FCCU	8-Hr	60.6552	337.2291	8.1794	4.29768	251,413.0	28.60
Scenario 3							
FCCU	1-Hr	60.6552	333.1145	6.5699	4.29768	201,939.4	34.74
FCCU	8-Hr	60.6552	332.8317	7.9805	4.29768	245,297.8	10.49

a. Stack Velocity calculated based on Stack Diameter and Stack Airflow.

[4] Parameters based on actual FCC unit startup events. Scenario 2 reflects the event on October 14, 2016 and Scenario 3 reflects the event on March 24, 2020.

5. MODEL RESULTS

5.1 SIL

Tables 4 and 5 summarize the modeled SIL results. In accordance with Illinois EPA guidance, the first high for the 1-hour and 8-hour averaging periods was compared with the corresponding 1-hour and 8-hour CO SIL. As shown in the tables, CITGO demonstrates compliance with CO's respective SIL standards, which means that the source does not cause a significant impact on the area surrounding the facility. The maximum impacts occur on the facility's fenceline and drop off rapidly with distance from there.

Table 4. Worst Case Scenario SIL Results[5]

Source Group ID	SIL Modeled Impact ($\mu g/m^3$)		SIL ($\mu g/m^3$)		Below the SIL?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 1					
FCCU	462.57	60.49	2,000	500	Yes

Table 5. Actual FCCU Event SIL Results[6]

Source Group ID	SIL Modeled Impact ($\mu g/m^3$)		SIL ($\mu g/m^3$)		Below the SIL?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 2					
FCCU	351.28	47.02	2,000	500	Yes
Scenario 3					
FCCU	154.36	18.04	2,000	500	Yes

[5] Parameters based on statistical worst case values for each of the four sources.

[6] Parameters based on actual FCC unit startup events. Scenario 2 reflects the event on October 14, 2016 and Scenario 3 reflects the event on March 24, 2020.

5.2 NAAQS

Tables 6 and 7 summarize the modeled NAAQS results. In accordance with Illinois EPA guidance, the second high for the 1-hour and 8-hour averaging periods was compared with the corresponding 1-hour and 8-hour CO NAAQS. As shown in the tables, CITGO demonstrates compliance with CO's respective NAAQS standards. Similar to the SIL results, the maximum impacts occur on the facility's fenceline and drop off rapidly with distance from there.

Table 6. Worst Case Scenario NAAQS Results[7]

Source Group ID	NAAQS Modeled Impact (µg/m³)		Background Concentration		NAAQS Modeled Impact w/ Background (µg/m³)		NAAQS (µg/m³)		Below the NAAQS?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 1									
FCCU	299.67	56.38	2,329.40	1,412.92	2,629.08	1,469.30	40,000	10,000	Yes

Table 7. Actual FCCU Event NAAQS Results[8]

Source Group ID	NAAQS Modeled Impact (µg/m³)		Background Concentration		NAAQS Modeled Impact w/ Background (µg/m³)		NAAQS (µg/m³)		Below the NAAQS?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 2									
FCCU	192.31	44.31	2,329.40	1,412.92	2,521.71	1,457.23	40,000	10,000	Yes
Scenario 3									
FCCU	97.06	17.08	2,329.40	1,412.92	2,426.46	1,430.00	40,000	10,000	Yes

[7] Parameters based on statistical worst case values for each of the four sources.

[8] Parameters based on actual FCC unit startup events. Scenario 2 reflects the event on October 14, 2016 and Scenario 3 reflects the event on March 24, 2020.

APPENDIX A. FIGURES

Figure 1. Receptor Grid

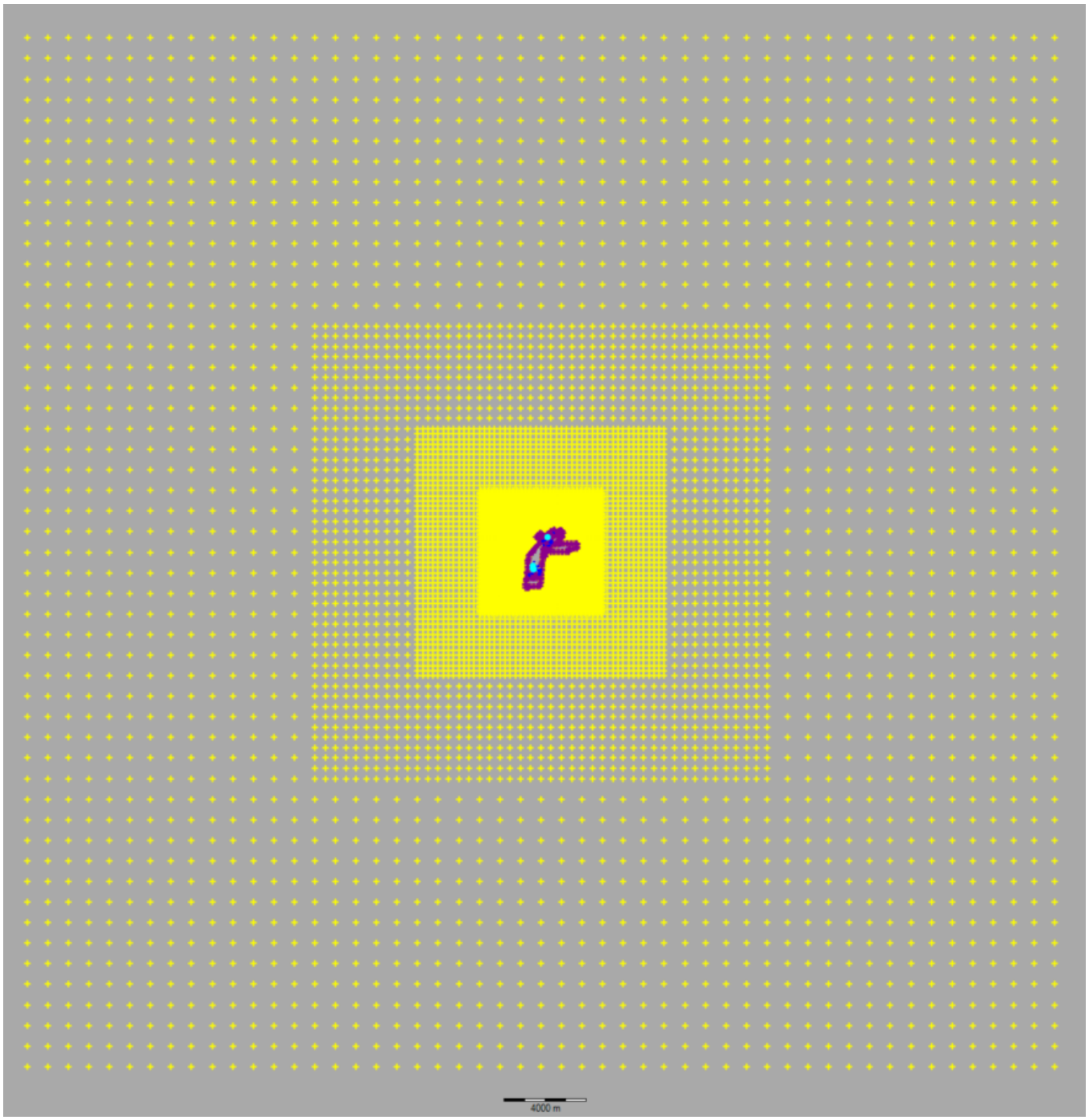

Figure 2. Boundary Receptor Grid

APPENDIX B. MODEL FILES

EXHIBIT 3

FCCU STARTUP MODELING REPORT

CITGO Petroleum Corporation, Inc. / Lemont, Illinois

Prepared By:

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January 4, 2024

Project 231401.0192

EXHIBIT 3

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1. BACKGROUND

CITGO Petroleum Corporation, Inc. (CITGO) is presenting this modeling report in response to the Illinois Environmental Protection Agency's (Illinois EPA) request to model startup conditions for the Fluid Catalytic Cracking Unit (FCCU) at CITGO's site in Lemont, Illinois (Lemont Facility). This report describes the modeling procedures that were used to evaluate whether the startup conditions of this unit causes or contributes to exceedances of the Significant Impact Levels (SILs) and National Ambient Air Quality Standards (NAAQS) for Carbon Monoxide (CO) 1-hour and 8-hour.

Trinity Consultants (Trinity) has conducted the modeling analyses in a manner that conforms to the applicable rules and requirements for dispersion modeling, including the following guidance documents:

- USEPA: *Guideline on Air Quality Models,* 40 CFR Part 51 - Appendix W (Revised, January 17, 2017).
- USEPA: *AERMOD Implementation Guide* (Revised, June 2022).

The remainder of this modeling report is organized as follows:

- Section 2 discusses modeling methodology;
- Section 3 discusses modeling requirements;
- Section 4 provides a brief description of the facility; and
- Section 5 provides the model results.

2. MODELING METHODOLOGY

2.1 UTM Coordinate System

The model, the locations of emission sources, structures, and receptors were represented in Universal Transverse Mercator (UTM) NAD83, Zone 16N.

2.2 Model Selection

Trinity conducted air dispersion modeling analyses using version 23132 of the AERMOD modeling system to estimate maximum ground-level concentrations associated with the facility. AERMOD is a refined, steady-state, multiple-source, Gaussian dispersion model and was promulgated in December 2005 as the preferred model for use by industrial sources in this type of air quality analysis.

The following modeling programs were utilized for the model run:

- AERMOD 23132
- BPIP PRIME 04274
- AERMAP 18081

2.3 Meteorological Data

Model-ready meteorological data was provided by Cari Rutherford of Illinois EPA on December 5, 2023. The data covered the years 2018-2022. Surface data was taken from O'Hare International Airport in Chicago, IL while upper air data was taken from the National Weather Service Forecast Office in Davenport, IA.

2.4 Treatment of Terrain

AERMAP (v18081) is the terrain pre-processor that is used to import terrain elevations for selected model objects and to generate the receptor hill height scale data that are used by AERMOD to drive advanced terrain processing algorithms. Trinity utilized 1/3-arcsecond National Elevation Dataset (NED) data available from the United States Geological Survey (USGS) to interpolate surveyed elevations onto user-specified receptor grids, buildings, and sources in the absence of more accurate site-specific (i.e., site surveys, GPS analyses, etc.) elevation data.

2.5 Receptor Grids

In the air dispersion modeling analysis, ground-level concentrations were calculated within five Cartesian receptor grids.[1] The grids are defined as follows:

- Fence Line Receptors[2]: A grid consisting of evenly spaced receptors 50 m apart placed along the facility's ambient air boundary
- 50-meter Cartesian Grid: A grid containing 50-meter space receptors extending approximately 1 km from the fenceline

[1] Receptor grid was created following Table 10 of Minnesota Pollution Control Agency (MPCA) Air Dispersion Modeling Practices, September 2022.

[2] Fenceline receptors were set up according to Illinois EPA's guidance document "The Art and Science of the PSD Air Quality Analysis The Modeling Perspective", July 2021.

- 100-meter Cartesian Grid: A grid containing 100-meter spaced receptors extending from 1 km to 2 km from the fenceline, exclusive of the receptors in the previous grids
- 250-meter Cartesian Grid: A grid containing 250-meter spaced receptors extending from 2 km to 5 km from the fenceline, exclusive of the receptors in the previous grids
- 500-meter Cartesian Grid: A grid containing 500-meter spaced receptors extending from 5 km to 10 km from the fenceline, exclusive of the receptors in the previous grids
- 1,000-meter Cartesian Grid: A grid containing 1,000-meter space receptors extending from 10 km to 50km from the fenceline, exclusive of the receptors in the previous grids.

Figure 1 in Appendix A displays the receptor grid layout.

2.6 Background Concentrations

The background concentrations used to model the cumulative CO impacts for the 1-hour and 8-hour standards were obtained using EPA's Interactive Map of Air Quality Monitors, and the Lansing, Illinois monitor (AQS Site ID 17-031-0119) was used for this project. The Lansing monitor is located adjacent to a heavily trafficked interstate roadway, I-80/94. Due to its proximity to this roadway, it is likely that the Lansing monitor measures extensive levels of vehicle emissions. The closest expressway to the Lemont Facility is two miles away (I-355) and is not as heavily trafficked as I-80/94. The concentrations observed at the Lansing monitor are considered conservative for the Lemont Facility because of the lower levels of expected vehicle emissions at the Lemont Facility. The average ppm concentration values from 2021 to 2023 were added to the modeling results to determine the cumulative impacts.

2.7 Building Downwash

AERMOD incorporates the Plume Rise Modeling Enhancements (PRIME) downwash algorithms and the direction-specific building downwash dimensions used as inputs are determined by the Building Profile Input Program, PRIME version (BPIP PRIME), version 04274. BPIP PRIME is designed to incorporate the concepts and procedures expressed in the GEP Technical Support document, the Building Downwash Guidance document, and other related documents, while incorporating the PRIME enhancements.

The heights, locations, and dimensions of buildings located on site were obtained from facility plot plans provided by CITGO.

Figure 2 in Appendix A displays the modeled buildings, which are shown in dark blue.

3. MODELING REQUIREMENTS

The objective of this analysis is to illustrate that the FCCU operating at the Lemont Facility does not cause or contribute to an exceedance of the SILs and/or NAAQS for CO.

Trinity, on behalf of CITGO, has conducted air dispersion modeling in accordance with the Illinois EPA's modeling guidance.

3.1 Significance Analysis

The significance analysis is conducted to determine whether the emissions associated with the startup conditions of the source cause a significant impact on the area surrounding the facility. "Significant" impacts are defined by ambient concentration thresholds commonly referred to as the SILs. Table 1 includes the SIL and NAAQS for CO.

Table 1. SILs and NAAQS for CO

Pollutant	Averaging Period	SIL ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
CO	8-Hour	500	10,000
	1-Hour	2,000	40,000

This modeling analysis will be used to demonstrate compliance with the standards included in Table 1.

3.2 NAAQS Analysis

The primary NAAQS are the maximum concentration ceilings, measured in terms of total concentration of a pollutant in the atmosphere, which define the "levels of air quality that the U.S. EPA judges are necessary, with an adequate margin of safety, to protect the public health." Secondary NAAQS define the levels that "protect the public welfare from any known or anticipated adverse effects of a pollutant." The NAAQS are shown in Table 1 for CO. The objective of the NAAQS Analysis is to demonstrate through air quality modeling that emissions associated with the startup conditions of the source does not contribute to or cause an exceedance of the NAAQS at any ambient location.

4. MODELING EMISSIONS INVENTORY

4.1 Modeled Source

Table 2 below includes an inventory of the point source included in the model.

Table 2. Modeled Point Source Inventory

Model ID	Description	Source Type
FCCU	Fluid Catalytic Cracking Unit	Point

4.2 Modeled Stack Parameters

Three different scenarios were modeled for the sake of this analysis to illustrate that the startup conditions of the FCCU do not exceed the SILs and NAAQS increments. The first scenario modeled the worst-case parameters for the unit. These parameters were based upon statistically based maximum emission rate (average + 2 standard deviations) and minimum velocity and temperature (average – 2 standard deviations). Scenario 2 and Scenario 3 modeled event-specific startup parameters for the FCCU. Scenario 2 reflected parameters from the maximum emission rate startup event caused by a unit trip on October 14, 2016. The last scenario, Scenario 3, represented the startup parameters for the FCCU's minimum velocity and temperature event on March 24, 2020, caused by an unplanned unit shutdown. A review of the startup event hourly emission rates showed that no event had a constant emission rate for 8-hours, and the 8-hour average emission rates were all less than the maximum 1-hour average. Accordingly, these 8-hour averages for the events were evaluated to determine separate 8-hour average emission rate inputs for each of the 3 scenarios modeled. Tables 3 and 4 below show the parameters for each source included in each scenario's model.

Table 3. Worst Case Point Source Stack Parameters[3]

Model ID	Averaging Period	Stack Height (m)	Stack Temperature (K)	Stack Velocity[a] (m/s)	Stack Diameter (m)	Stack Airflow (acfm)	CO Emission Rate (g/s)
Scenario 1							
FCCU	1-Hr	60.6552	331.5101	6.0864	4.29768	201,939.4	101.84
FCCU	8-Hr	60.6552	329.7202	6.0541	4.29768	186,086.5	29.09

a. Stack Velocity calculated based on Stack Diameter and Stack Airflow.

[3] Parameters based on statistical worst case values.

Table 4. Actual FCCU Event Point Source Stack Parameters[4]

Model ID	Averaging Period	Stack Height (m)	Stack Temperature (K)	Stack Velocity[a] (m/s)	Stack Diameter (m)	Stack Airflow (acfm)	CO Emission Rate (g/s)
Scenario 2							
FCCU	1-Hr	60.6552	334.2117	9.8718	4.29768	303,433.0	89.68
FCCU	8-Hr	60.6552	337.2291	8.1794	4.29768	251,413.0	28.60
Scenario 3							
FCCU	1-Hr	60.6552	333.1145	6.5699	4.29768	201,939.4	34.74
FCCU	8-Hr	60.6552	332.8317	7.9805	4.29768	245,297.8	10.49

a. Stack Velocity calculated based on Stack Diameter and Stack Airflow.

[4] Parameters based on actual FCC unit startup events. Scenario 2 reflects the event on October 14, 2016 and Scenario 3 reflects the event on March 24, 2020.

5. MODEL RESULTS

5.1 SIL

Tables 4 and 5 summarize the modeled SIL results. In accordance with Illinois EPA guidance, the first high for the 1-hour and 8-hour averaging periods was compared with the corresponding 1-hour and 8-hour CO SIL. As shown in the tables, CITGO demonstrates compliance with CO's respective SIL standards, which means that the source does not cause a significant impact on the area surrounding the facility. The maximum impacts occur on the facility's fenceline and drop off rapidly with distance from there.

Table 4. Worst Case Scenario SIL Results[5]

Source Group ID	SIL Modeled Impact ($\mu g/m^3$)		SIL ($\mu g/m^3$)		Below the SIL?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 1					
FCCU	462.57	60.49	2,000	500	Yes

Table 5. Actual FCCU Event SIL Results[6]

Source Group ID	SIL Modeled Impact ($\mu g/m^3$)		SIL ($\mu g/m^3$)		Below the SIL?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 2					
FCCU	351.28	47.02	2,000	500	Yes
Scenario 3					
FCCU	154.36	18.04	2,000	500	Yes

[5] Parameters based on statistical worst case values for each of the four sources.

[6] Parameters based on actual FCC unit startup events. Scenario 2 reflects the event on October 14, 2016 and Scenario 3 reflects the event on March 24, 2020.

5.2 NAAQS

Tables 6 and 7 summarize the modeled NAAQS results. In accordance with Illinois EPA guidance, the second high for the 1-hour and 8-hour averaging periods was compared with the corresponding 1-hour and 8-hour CO NAAQS. As shown in the tables, CITGO demonstrates compliance with CO's respective NAAQS standards. Similar to the SIL results, the maximum impacts occur on the facility's fenceline and drop off rapidly with distance from there.

Table 6. Worst Case Scenario NAAQS Results[7]

Source Group ID	NAAQS Modeled Impact (µg/m³)		Background Concentration		NAAQS Modeled Impact w/ Background (µg/m³)		NAAQS (µg/m³)		Below the NAAQS?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 1									
FCCU	299.67	56.38	2,329.40	1,412.92	2,629.08	1,469.30	40,000	10,000	Yes

Table 7. Actual FCCU Event NAAQS Results[8]

Source Group ID	NAAQS Modeled Impact (µg/m³)		Background Concentration		NAAQS Modeled Impact w/ Background (µg/m³)		NAAQS (µg/m³)		Below the NAAQS?
	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	CO/1-Hr	CO/8-Hr	
Scenario 2									
FCCU	192.31	44.31	2,329.40	1,412.92	2,521.71	1,457.23	40,000	10,000	Yes
Scenario 3									
FCCU	97.06	17.08	2,329.40	1,412.92	2,426.46	1,430.00	40,000	10,000	Yes

[7] Parameters based on statistical worst case values for each of the four sources.

[8] Parameters based on actual FCC unit startup events. Scenario 2 reflects the event on October 14, 2016 and Scenario 3 reflects the event on March 24, 2020.

APPENDIX A. FIGURES

Figure 1. Receptor Grid

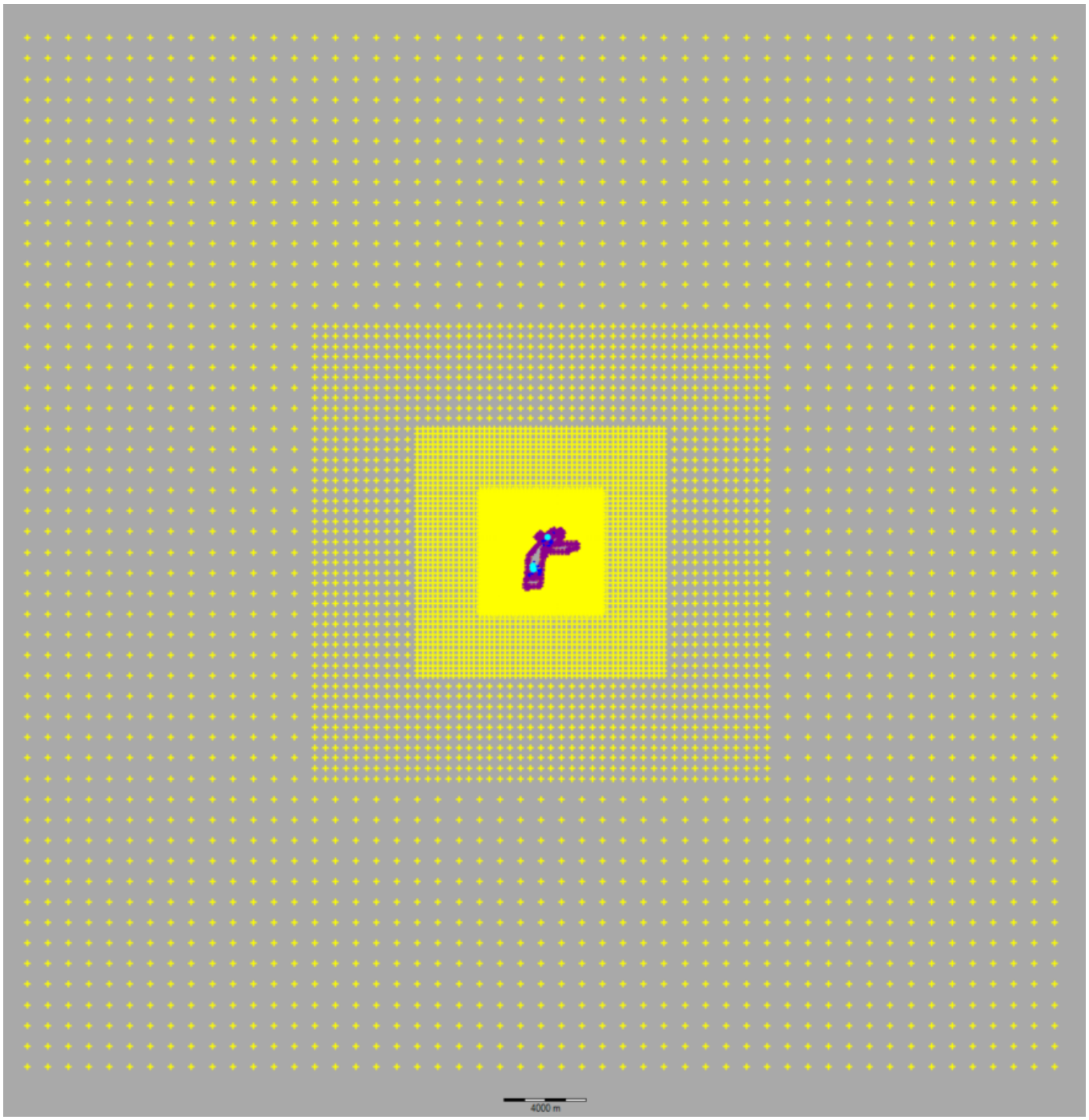


Figure 2. Boundary Receptor Grid

APPENDIX B. MODEL FILES

EXHIBIT 4

Marathon Petroleum Company LP

Illinois Refining Division (Robinson Refinery)

FCCU Startup and Carbon Monoxide Monitor Data Summary in support of API's Proposed Alternative Emission Limitation with the Illinois Pollution Control Board

Submitted March 15, 2024

EXHIBIT 4

Technical Support Narrative – Carbon Monoxide Formation & Control

Excess carbon monoxide ("CO") formed and emitted during the startup phase of a Fluid Catalytic Cracking Unit (FCCU or "Cat") is generally caused by slow ramping of process unit temperature and balancing available air through these temperature increases. Typically, CO from an FCCU is controlled by a CO boiler. During startup, flue gas is introduced into the CO boiler just prior to the introduction of torch oil into the FCCU. Supplemental gas is also required to bring the temperature of the CO boiler up to 980°C/1800°F to ensure complete combustion of CO. At these temperatures, very low concentrations are achievable from a CO boiler. However, until the entire FCCU system reaches the steady-state, normal operations as described controls cannot reduce the excess CO to below the 200 ppm standard required in 35 IAC 216.361.

Other controls available for CO, such as oxidation catalysts, offer little to no advantages over a CO boiler. At very high temperatures and/or ramp rates, these are subject to catalyst damage and can be fouled. In addition, they do not provide the heat recovery in the form of usable steam that a CO boiler provides to a refinery. The steam produced from the heat release of CO combustion reduces the demand for steam from other fired boilers therefore increasing the efficiency of the refinery as a whole and offsetting emissions from those sources while controlling CO. Because oxidation catalyst still requires elevated temperatures, but do not product heat recovery/steam generation, a CO boiler is the preferred control option for FCCUs.

The only feasible manner in which to control CO during startup is to use good combustion and operating practices to bring the FCCU system up to temperature as quickly and safely as allowed. During this time, CO can exceed 200 ppm until startup is exited and the CO boiler temperatures are stabilized. Therefore, there is no feasible engineering control option during startups to meet Section 216.361 other than the work practices proposed by API as part of the AEL.

In general, FCCU startups are infrequent events. An FCCU is the "heart" of a refinery used to process a significant intermediate of crude oil called gasoil. The products of an FCCU are then used in several downstream process units. Coupled with the complexity of an FCCU startup, a refinery has a technical and economic incentive to minimize the time and duration of startups. In the past six plus years from January 1, 2017 to July 1, 2023, the Robinson refinery has initiated 20 startup attempts of its FCCU for a total duration of approximately 485 hours. The average startup lasted 25.5 hours during this period of time. This represents <1% of available hours.

While no two startups are identical events, in general, excess CO emissions do not last the entire startup period. Usually, what is observed, are relatively brief spikes lasting 1-2 hours in the CO concentration as the facility steps through the startup process, bringing various parts of the system online. Startup mass emissions (lb/hr) and concentration (ppm) vs. time graphs are included below which demonstration this. As shown by the CO mass emission graphs, the duration and amount of CO are significantly different. FCCU startups are very complex and complicated events that can affect not only the unit itself, but other process units at the facility, depending on the original reason of the shutdown as well as a multitude of other variables. However, as further evidenced, the CO mass emissions range from very low to >250 lb/hr short duration peaks during startup (during the monitor study period).

The FCCUs and associated air pollution control and monitoring equipment are operated in a manner consistent with safety and good air pollution control practices for minimizing emissions, including periods of startup and malfunction. These practices include following established startup procedures to protect personnel, process equipment, and minimize emissions to the furthest extent possible although it is recognized in the general provisions of MACT that emissions during startup, shutdown, and malfunction may not achieve emission levels that would be required by applicable standards at other times.

Prior to the startup of the FCCU, the Flue Gas Scrubbing System (FGSS) is placed in service and is available for treatment of flue gas from each stage of the startup sequence. During the startup of the FCCU, the regenerator is initially heated with a fired air-preheater. The temperature must be raised slowly and is established by the refractory and air-preheater manufacturer's recommendations. Combustion is monitored and available air is adjusted based on oxygen samples and analyzer readings during this time to facilitate complete combustion and minimize the formation of carbon monoxide. Flue gases during this stage of the startup are from the air-preheater and are controlled by the FGSS.

To achieve the required temperatures for FCCU operation, torch oil must be introduced to facilitate the heat up of the regenerator. This must be done following the initial heat up from the air-preheater to ensure that the torch oil is able to combust. Prior to torch oil being introduced, the flue gas is directed to the CO boiler for emission control. During this time, the amount of torch oil, air flow, and available oxygen are closely monitored to ensure that the torch oil is achieving complete combustion. During the initial introduction of torch oil temperatures are lower than normal operations which results in CO concentrations typically higher during this stage of the startup. The emissions are minimized by controlling combustion as much as possible at the regenerator and utilizing the CO boiler for control.

The torch oil will remain in the FCCU regenerator as the catalyst begins to circulate and the reactor is heated. Once temperature thresholds have been achieved, feed (gasoil) will be introduced into the unit and the coke on the catalyst in the regenerator will begin to combust and contribute to the heat balance around the regenerator and reactor. Torch oil will be slowly reduced prior to being removed and as operation stabilizes the heat balance, CO will drop to normal operating levels. The FCCU has the capacity to operate in full burn and partial burn modes. When the FCCU is operating in partial burn, the flue gas will continue to be routed to the CO boiler for control. This is necessary because the regenerator operates with no excess oxygen to facilitate complete combustion and CO production remains elevated. The CO destruction occurs within the CO boiler in this mode of operation. When the FCCU is operating in full burn, the regenerator operates with excess oxygen and resulting in low concentrations of CO. In this mode of operation, the flue gas does not require treatment in the CO boiler and can be routed directly to the FGSS.

Monitor Study Summary

During calendar years 2017-2019, the Marathon Robinson Refinery was required to monitor impacts of its operations at two monitoring stations. Site #1 was placed at the location of maximum refinery impact (from modeling), site #2 was placed in the second most likely impact location based on long term wind patterns. CO was one of the pollutants monitored. Marathon voluntarily continued this monitoring into 2020 resulting in four years of data being captured, including startup events. During this study period, there were 10 startups of the FCCU. None of these startups resulted in the high hourly, second high hourly, nor max 8 hr CO reading for that calendar year. Therefore, these short spikes during startup did not result in NAAQS violations - nor any measurable increases in ambient CO, and therefore have little to no negative measurable impact on ambient air quality.

The following summary table provides CO relevant data:

Parameter	Site #1	Site #2	S/U During Max (Y/N)
8 Hr. Running Average	1.2 ppm	0.5 ppm	N/A
1 Hr. Average	1.8 ppm	1.3 ppm	N/A
2017 Max 1-hour	0.8 ppm (8/1/17)	1.2 ppm (2/1/17)	N
2017 2nd High 1-hr	0.7 ppm (multiple)	1.0 ppm (5/30/17)	N
2017 Max 8 hr	0.6 ppm (12/3/17)	0.7 ppm (multiple)	N
2018 Max 1-hr	0.8 ppm (12/18/2017)	1.9 ppm (1/17/18)	N
2018 2nd High 1-hr	0.7 ppm (10/18/18 2x and 12/17/18)	1.1 (1/17/18, 1/28/18, 12/17/18)	N
2018 Max 8 hr	0.5 ppm (multiple)	0.8 ppm (multiple)	N
2019 Max 1-hr	1.8 ppm (11/10/19)	0.9 ppm (multiple)	N
2019 2nd high 1-hr	1.7 ppm (11/11/19)	0.8 ppm (4/2/19, 8/1/19)	N
2019 Max 8 hr	1.2 ppm (11/11/2019 2x)	0.6 ppm (3/18/2019)	N

For reference, the 8-hr NAAQS for CO is 9 ppm not to be exceeded more than once per year and the 1-hour NAAQS is 35 ppm not to be exceeded more than once per year. In no instance over four years were any readings over 15% of the 8-hour and the max 1-hour was approximately 5% of the standard. As shown in the table, there is little difference between the 8-hour and 1-hour averages which further demonstrates that periodic startups at the FCCU have little to no effect on the CO concentrations outside of the fenceline. The closest CO NAAQS regulatory monitoring location is near Evansville, IN. Concentrations recorded at Robinson during the study are similar to those at Evansville further evidence of how activities in the refinery – including FCCU startups – have little to no impact on ambient CO concentrations.

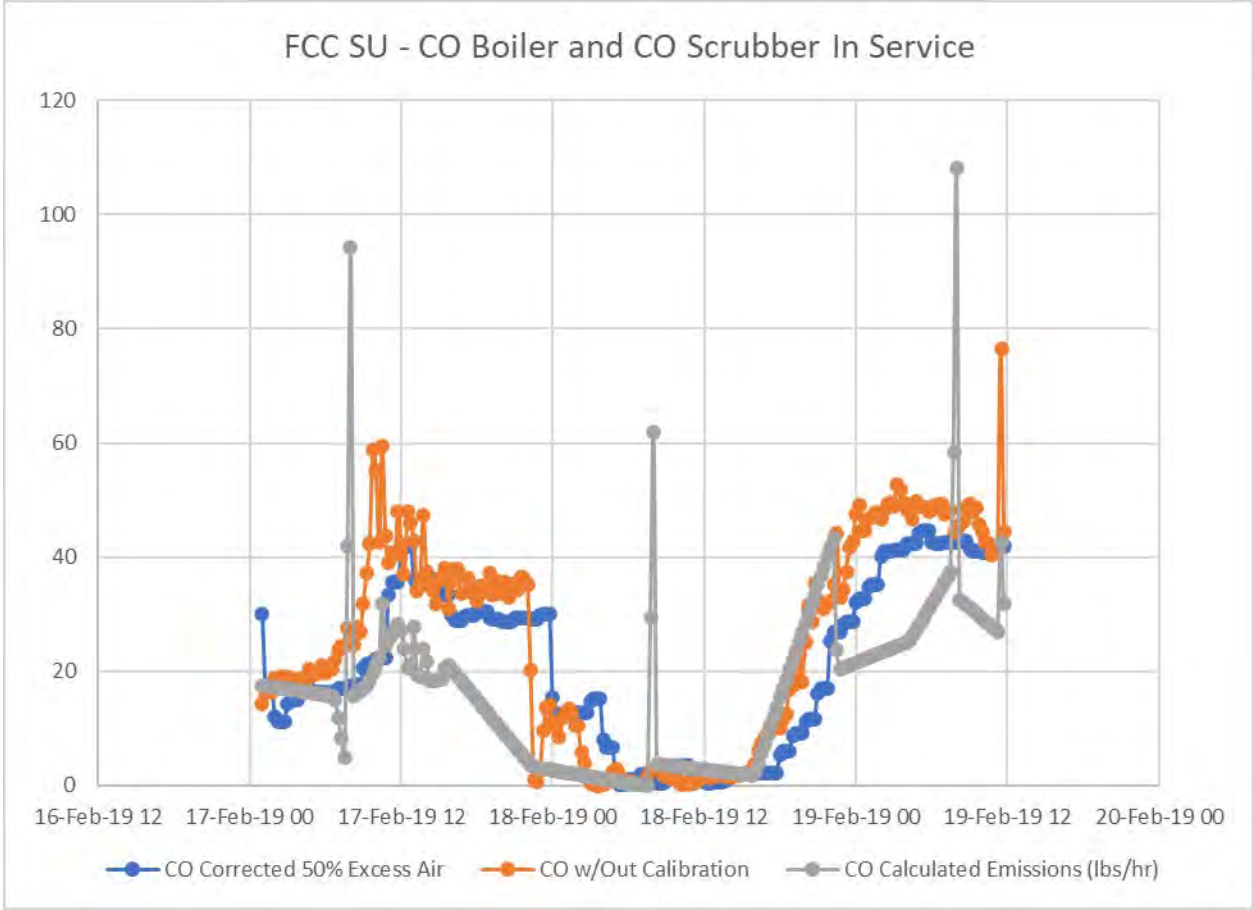
The study was submitted to the Illinois EPA as part of the agreement and the Agency has all summary and raw data reports on file.

Startup up FCCU Carbon Monoxide Graphs (Concentration and Mass vs. Time)

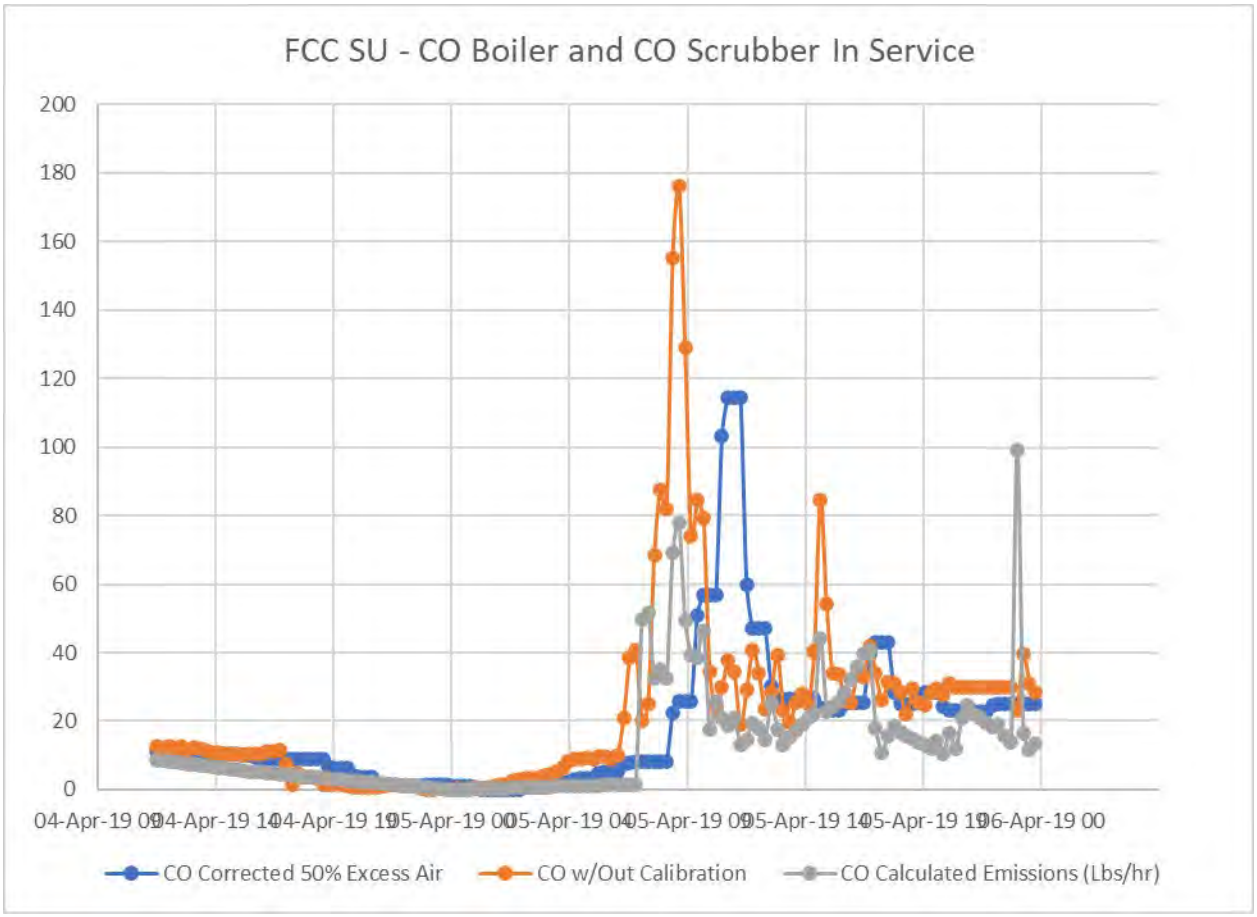
Legend for Graphs:

Blue Line – Carbon Monoxide concentration (ppm) at 50% excess air
Orange Line – Carbon Monoxide concentration (ppm) without excess air correction
Gray Line – Carbon monoxide mass emission rate in pounds per hour
Date and Time across X axis
Concentration (ppm) & Mass Rate (lb/hr) on Y axis

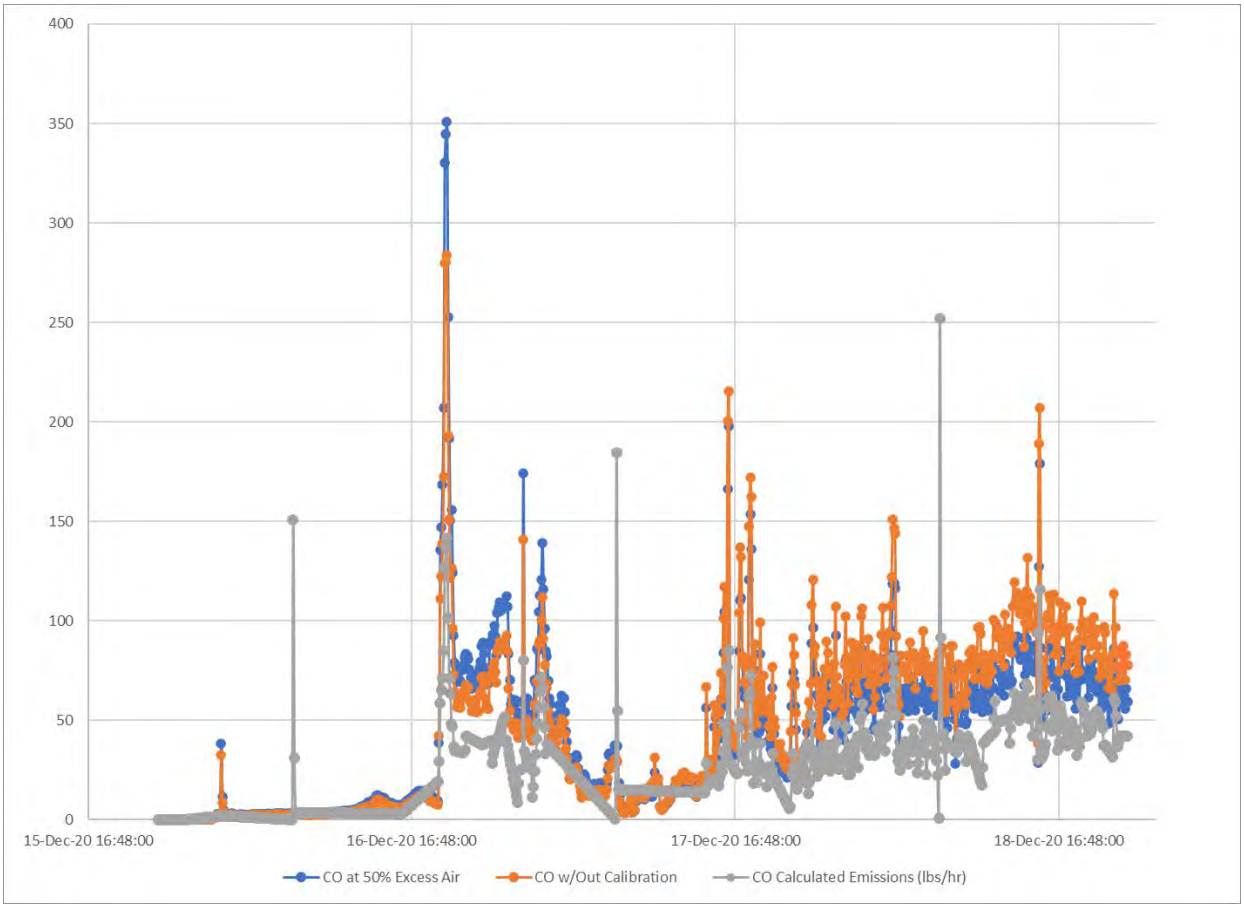
February 16, 2019 Startup



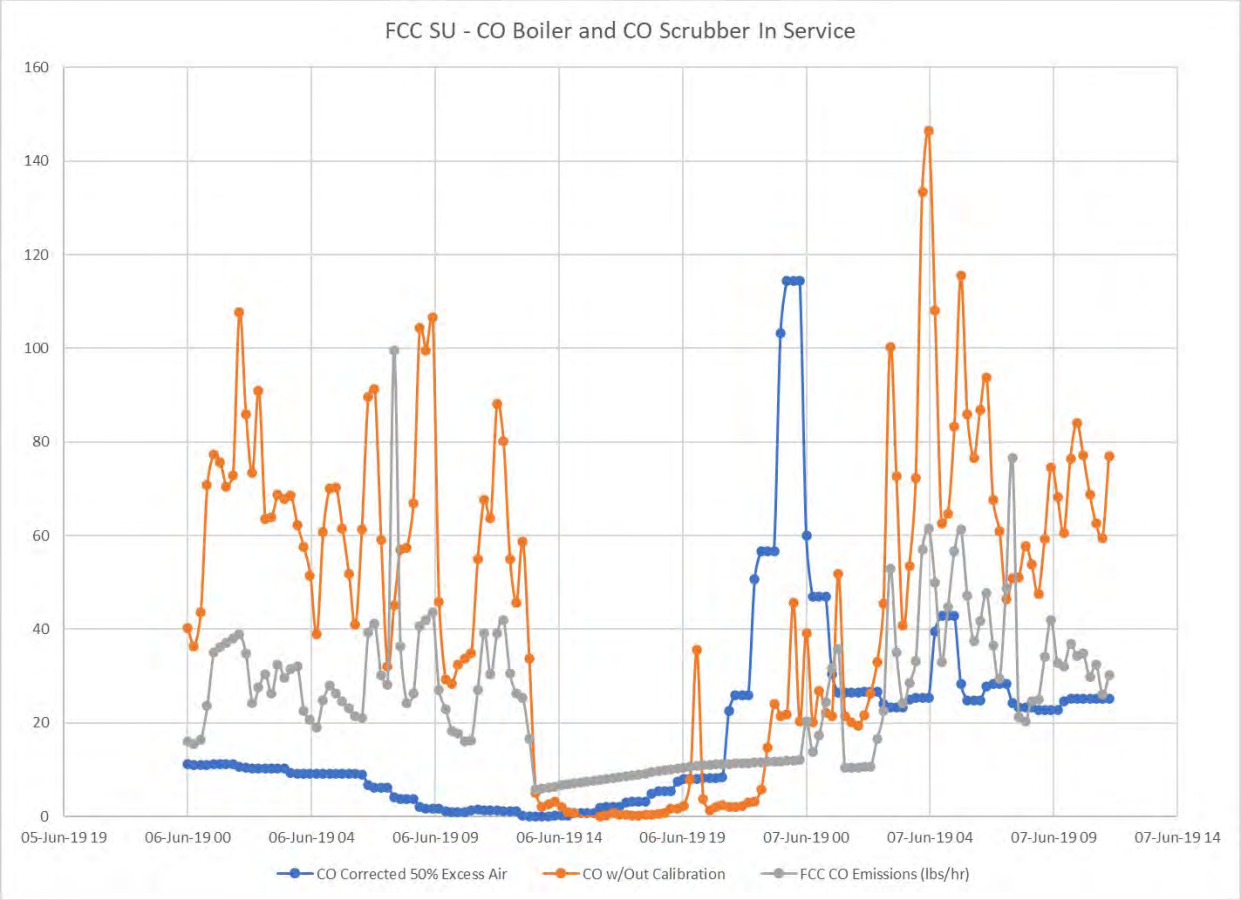
April 4, 2019 Startup



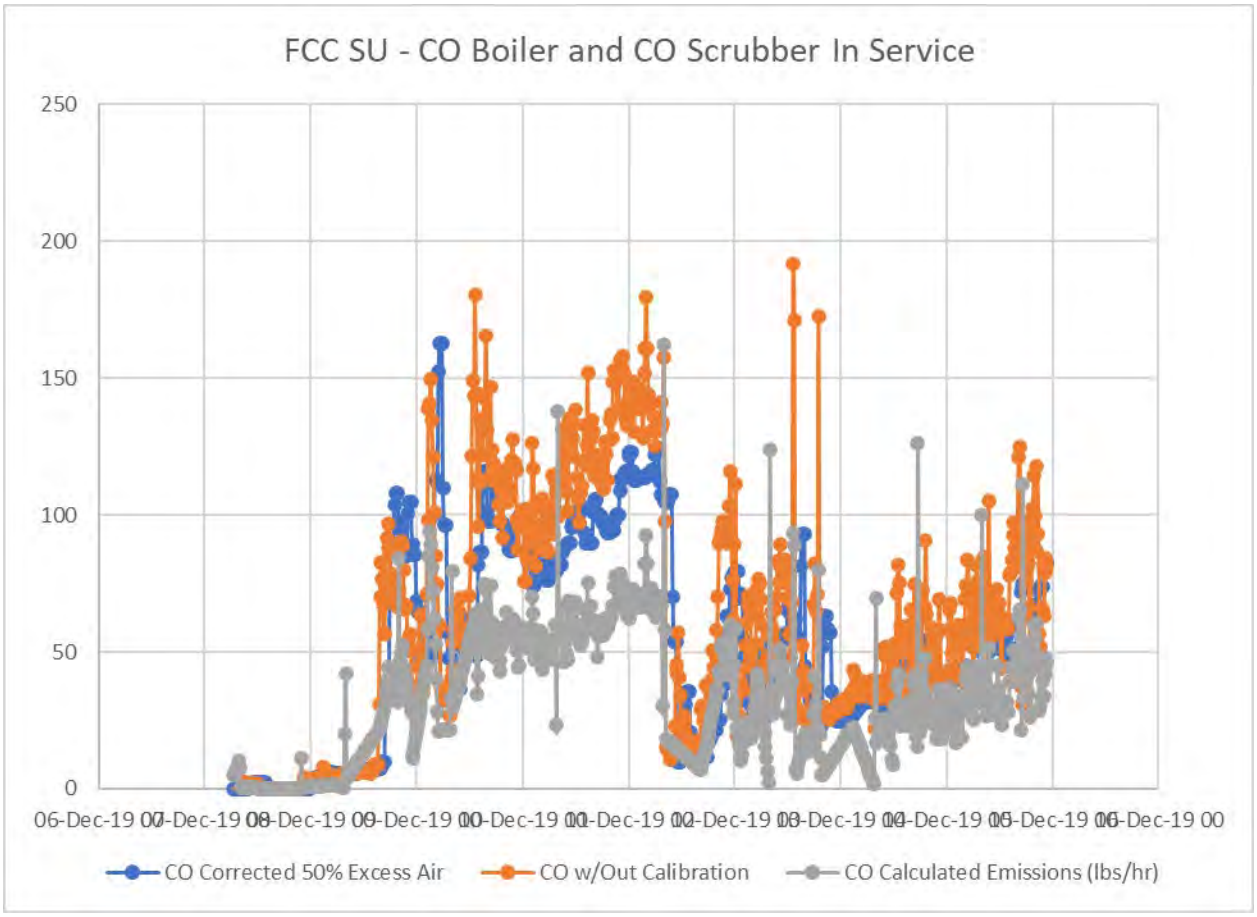
December 12, 2020 Startup



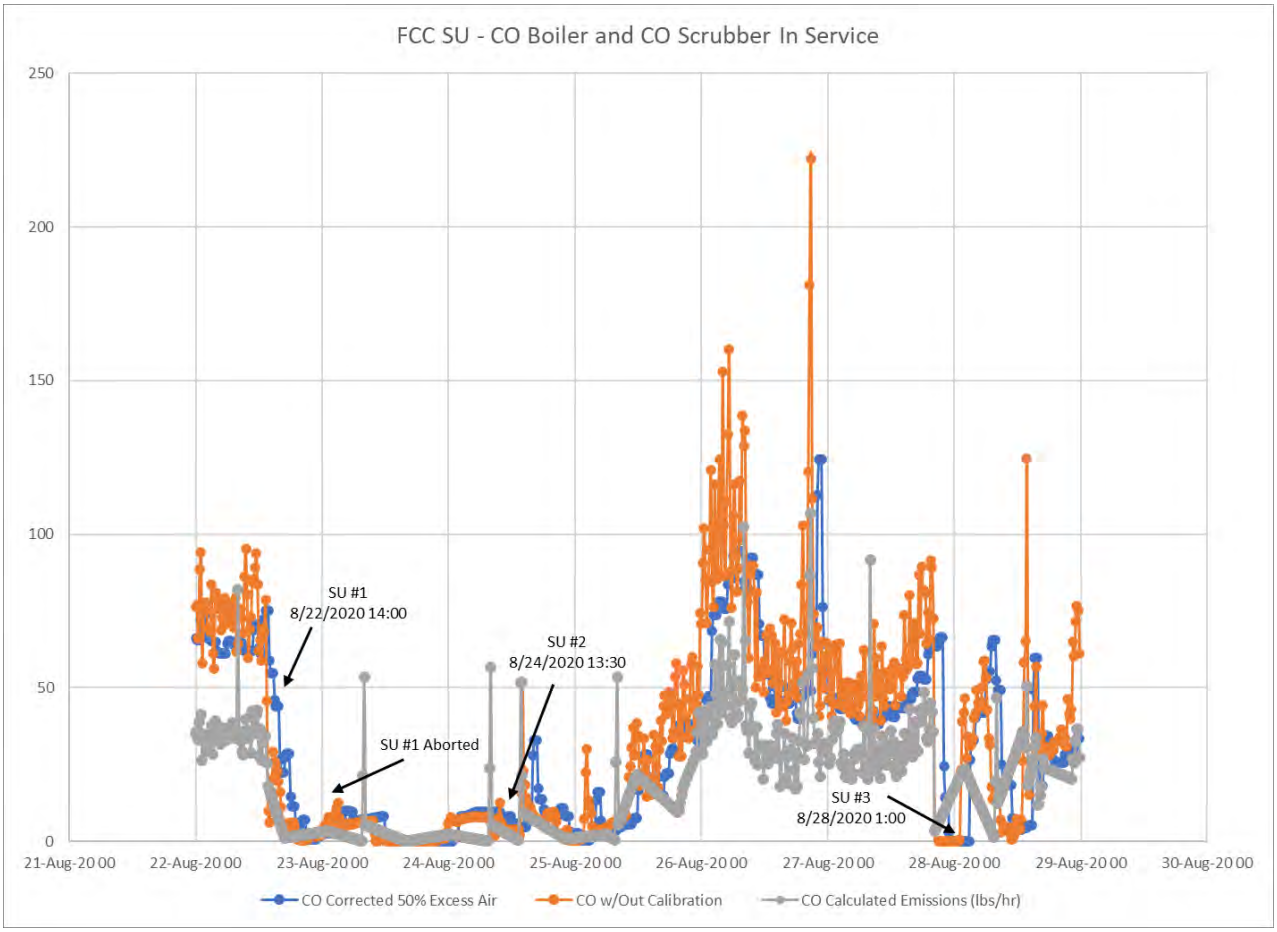
June 6, 2019 Startup



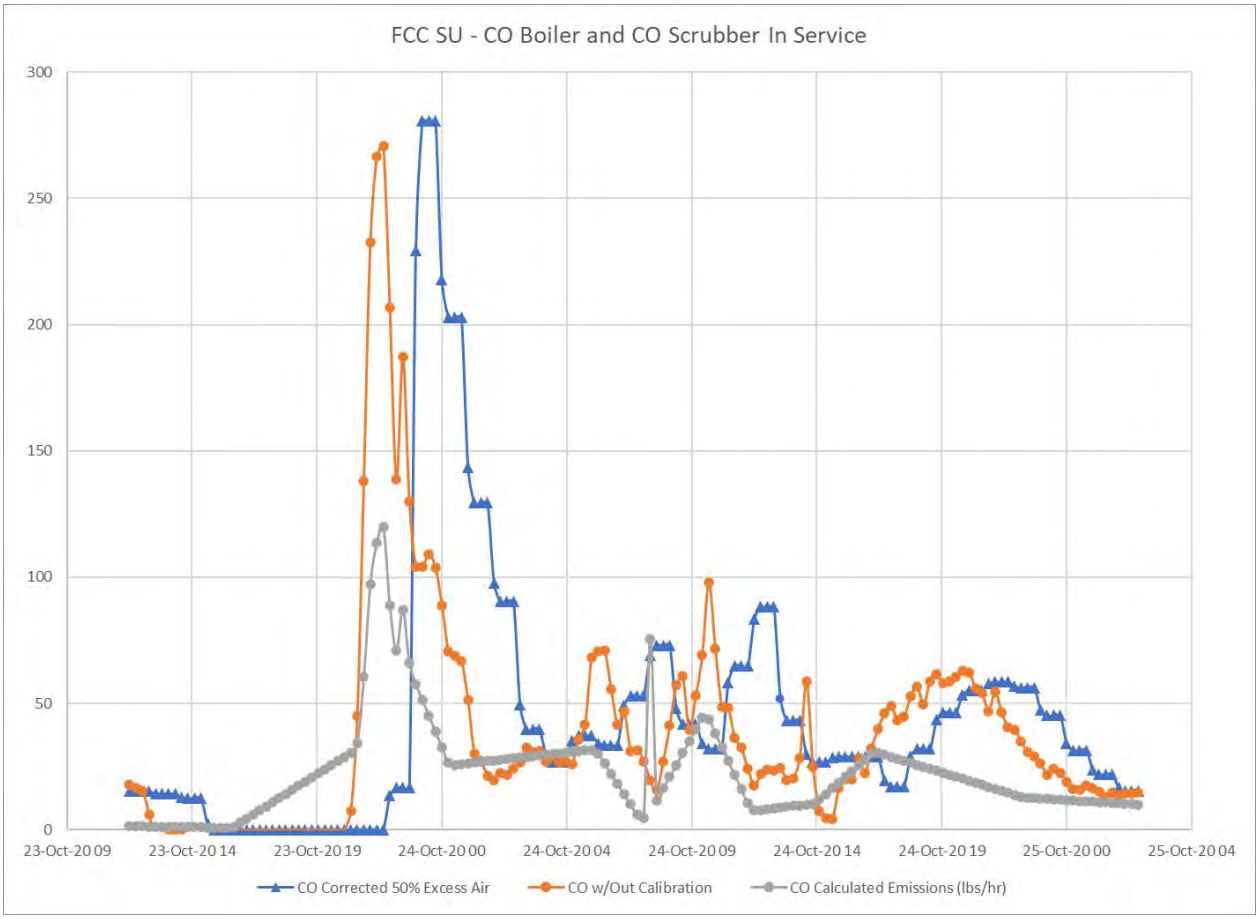
November 7, 2019



August 22, 24, & 28, 2020 (three separate startup attempts)



October 22, 2020



December 15, 2020