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June 13, 2016

Pollution Control Board, Attn: Clerk  
100 West Randolph Street  
James R. Thompson Center, Suite 11-500  
Chicago, Illinois 60601-3218

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CLERK'S OFFICE

JUN 16 2016

STATE OF ILLINOIS  
Pollution Control Board

PK B16-112



ORIGINAL

Re: Petition Requesting Temporary Variance of Title 35 IAC Section 214.161(b)(2)  
Zion Energy Center - Facility ID No. 097200ABB

Dear Pollution Control Board Clerk:

Please find enclosed a petition requesting temporary variance of Title 35 IAC Section 214.161(b)(2) for the Zion Energy Center (Facility ID No. 097200ABB) located in Zion, IL. Zion Energy Center (the Facility) is operated by Calpine Operating Services Company, Inc. (Calpine). The Facility operates under a Clean Air Act Permit Program (CAAPP) permit issued on October 16, 2014. The Facility currently owns three (3) simple cycle natural gas fired turbines with distillate oil as back up fuel to generate electricity. Each turbine is equipped with dry low NO<sub>x</sub> combustors for natural gas firing and water injection for oil firing.

The Facility is submitting this petition to the Illinois Pollution Control Board (Board) requesting temporary variance from the following Title 35 of Illinois Administrative Code (IAC) rule:

- Section 214.161(b)(2) that limits the sulfur content of all distillate oil used by fuel combustion sources less than 15 ppm, and

The updates to Rule 214.161 became effective on December 7, 2015.

Calpine operates a large distillate oil tank. The tank currently has a significant amount of fuel with a sulfur content greater than 15 ppm. The Facility is seeking additional time to combust the distillate oil remaining in the storage tank that exceeds the 15 ppm sulfur content limit. This document has been prepared in accordance with variance filing requirements as described by Title 35 IAC Section 104.202.

The following documents are being submitted in triplicate:

- Temporary Variance Request Report;
- The original signed Affidavit and Hearing Request Denial; and
- A check in the amount of \$75 for the variance request.

Should you have any questions on the enclosed permit application, please contact me at (302) 468-5381 or by email at [hwhidden@calpine.com](mailto:hwhidden@calpine.com). You may also contact Charles Balcerek at Wenck Associates at (651) 395-5210 or by email at [cbalcerek@wenck.com](mailto:cbalcerek@wenck.com).

Sincerely,

CALPINE CORPORATION

Heidi M. Whidden  
Director, Environmental Services East Region

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STATE OF ALABAMA  
MONTGOMERY



Original

WENCK File #1294-0036  
June 2016

# Petition for Variance

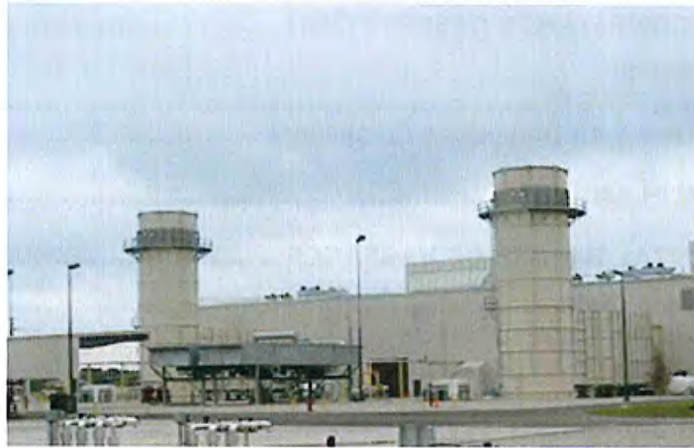
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JUN 1'6 2016

STATE OF ILLINOIS  
Pollution Control Board



**ORIGINAL**



*Submitted by:*  
**Calpine Corporation**

5701 West Ninth Street  
Zion, IL 50099



Responsive partner.  
Exceptional outcomes.

*Prepared by:*

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## Executive Summary

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Zion Energy Center (the Facility) currently owns three (3) simple cycle natural gas fired turbines with distillate oil as back up fuel to generate electricity. Each turbine is equipped with dry low NO<sub>x</sub> combustors for natural gas firing and water injection for oil firing. The Facility is operated by Calpine Operating Services Company, Inc. (Calpine).

The Facility is submitting this petition to the Illinois Pollution Control Board (Board) requesting temporary variance from the following Title 35 of Illinois Administrative Code (IAC) rule:

- Section 214.161(b)(2) that limits the sulfur content of all distillate oil used by fuel combustion sources less than 15 ppm, and

The updates to Rule 214.161 became effective on December 7, 2015.

Calpine operates a large distillate oil tank. The tank currently has a significant amount of fuel with a sulfur content greater than 15 ppm. The Facility is seeking additional time to combust the distillate oil remaining in the storage tank that exceeds the 15 ppm sulfur content limit. This document has been prepared in accordance with variance filing requirements as described by Title 35 IAC Section 104.202.

## Petition Requirements

Title 35 IAC Section 104.204 lists the required information for necessary for the Board to grant variance to any rule, regulation or requirements that impose hardship on the petitioner. The required information for the enclosed variance to rule 214.161(b)(2) is contained in the following sections and summarized below in Table 1:

Table 1. Summary of Title 35 IAC Section 104.204 Requirements

<b>Section 104.204</b> <b>The petition must include the information required by subsections (a) through (n) of this Section. Additionally, there are specific content requirements set forth at Section 104.206 of this Part for RCRA variance petitions. If the petitioner believes that any of these requirements are not applicable to the specific variance requested, the petitioner must so state and explain the reasoning.</b>	<b>Location in the Enclosed Variance Request Document</b>
a) A statement describing the regulation, requirement, or order of the Board from which a variance is sought. If variance from a regulation is sought, the statement must include the Illinois Administrative Code citation to the regulation as well as the effective date of that regulation. If variance from a requirement or order of the Board is sought, the statement must include the citation to that requirement or order of the Board promulgating that requirement, including docket number;	Section 1.0
b) A complete and concise description of the nature of petitioner's activity that is the subject of the proposed variance, including:	
1) The location of, and area affected by, the petitioner's activity;	Section 2.0
2) The location of points of discharge, and, as applicable, the identification of the receiving waterway or land, or, if known, the location of the nearest air monitoring station maintained by the Agency;	Section 2.0 and Appendix A
3) An identification, including docket number, of any prior variance issued to the petitioner and, if known, the petitioner's predecessors, concerning similar relief;	Not Applicable, stated in Section 2
4) An identification, including number, of the environmental permits held by petitioner for the activity which may be affected by grant of variance;	Section 2.0
5) The number of persons employed by the petitioner's facility at issue and the age of that facility;	Section 2.0
6) The nature and amount of the materials used in the process or activity for which the variance is sought and a full description of the particular process or activity in which the materials are used;	Section 2.0
7) A description of the relevant pollution control equipment already in use; and	Section 2.0
8) The nature and amount of emissions, discharges or releases of the constituent in question currently generated by the petitioner's activity;	Section 2.0
c) Data describing the nature and extent of the present or anticipated failure to meet the regulation, requirement, or order of the Board from which variance is sought and facts that support petitioner's argument that compliance with the regulation, requirement, or order of the Board was	Section 3.0

not or cannot be achieved by any required compliance date;	
d) A description of the efforts that would be necessary for the petitioner to achieve immediate compliance with the regulation, requirement, or Board order at issue. All possible compliance alternatives, with the corresponding costs for each alternative, must be set forth and discussed. The discussion of compliance alternatives must include the availability of alternate methods of compliance, the extent that the methods were studied, and the comparative factors leading to the selection of the control program proposed for compliance. The discussion of the costs of immediate compliance may include the overall capital costs and the annualized capital and operating costs;	Section 4.0
e) Facts that set forth the reasons the petitioner believes that immediate compliance with the regulation, requirement, or order of the Board would impose an arbitrary or unreasonable hardship;	Section 4.3
f) A detailed description of the compliance plan, including:	Section 5.0
1) A discussion of the proposed equipment or proposed method of control to be undertaken to achieve full compliance with the regulation, requirement, or order of the Board;	Section 5.0
2) A time schedule for the implementation of all phases of the control program from initiation of design to program completion; and	Section 5.0
3) The estimated costs involved for each phase and the total cost to achieve compliance;	Section 5.0
g) A description of the environmental impact of the petitioner's activity including:	
1) The nature and amount of emissions, discharges, or releases of the constituent in question if the requested variance is granted, compared to that which would result if immediate compliance is required;	Section 6.1 and 6.2
2) The qualitative and quantitative description of the impact of petitioner's activity on human health and the environment if the requested variance is granted, compared to the impact of petitioner's activity if immediate compliance is required. Cross-media impacts, if any, must be discussed; and	Section 6.2
3) A statement of the measures to be undertaken during the period of the variance to minimize the impact of the discharge of contaminants on human, plant, and animal life in the affected area, including the numerical interim discharge limitations that can be achieved during the period of the variance;	Section 5.0 and 6.1
h) Citation to supporting documents or legal authorities whenever they are used as a basis for the petition. Relevant portions of the documents and legal authorities other than Board decisions, reported state and federal court decisions, or state and federal regulations and statutes must be appended to the petition;	Section 7.0
i) If the requested variance involves an existing permit or a pending permit application, a copy of the material portion of the permit or permit application must be appended to the petition;	Appendix B
j) Any conditions petitioner suggests for the requested variance;	Section 5.0
k) A proposed beginning and ending date for the variance. If the petitioner requests that the term of the variance begin on any date other than the date on which the Board takes final action on the petition, a	Section 5.0



detailed explanation and justification for the alternative beginning date;	
l) A discussion of consistency with federal law, including an analysis of applicable federal law and facts that may be necessary to show compliance with federal law as set forth in Section 104.208 of this Part;	Section 2.0
m) An affidavit verifying any facts submitted in the petition; and	Appendix C
n) A statement requesting or denying that a hearing should be held in this matter.	Appendix C

## 1.0 Regulation Description

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Title 35 IAC Part 214 Subpart D contains the rules for sulfur emissions from existing liquid or mixed fuel combustion emission sources. The equipment configuration at the facility does not allow for simultaneous combustion of different fuels.

Section 214.161 rule changes became effective on December 7, 2015. The updated rule restricts the sulfur content of distillate oil to less than 15 ppm after January 1, 2017. Section 214.161 (b)(2) states the sulfur content of all distillate oil used by a combustion source must not exceed 15 ppm after January 1, 2017.

## 2.0 Description of Petitioner's Subject Activity

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As mentioned previously, Zion Energy Center (the Facility) currently owns 3 simple cycle natural gas fired turbines (combustion turbines or CTs) with distillate oil as back up fuel to generate electricity. Each turbine is equipped with dry low NO<sub>x</sub> combustors for natural gas firing and water injection for oil firing. The Facility does not have any add-on controls for sulfur dioxide (SO<sub>2</sub>) emissions, rather the facility controls SO<sub>2</sub> emissions by limiting the fuel sulfur content.

The Facility is operated by Calpine. The Facility is located at 5701 West Ninth Street, Zion, Lake County, Illinois. The Facility has not requested any variances from the Board prior to this submittal.

The Facility operates under a Clean Air Act Permit Program (CAAPP) permit that was re-issued on October 16, 2014 (ID No 097200ABB, Application No 99110042). Each turbine exhausts to a stack 75 feet tall and 18 feet in diameter. A figure with the site layout, including stack locations, is included in Appendix A. The Facility has been in operation since 2001 and currently employs 7 people.

The Facility is currently permitted to emit 78.0 tons per year (TPY) and 96.0 pounds per hour (lb/hr) SO<sub>2</sub> when operating on distillate oil (no greater than 480 ppm sulfur). The Facility will be limited to 13.2 TPY and 2.92 lb/hr SO<sub>2</sub> when operating on distillate oil (no greater than 15 ppm sulfur) after January 1, 2017.

The turbines are subject to 40 CFR 60 Subpart GG for Stationary Combustion Turbines. The fuel sulfur content limit for Subpart GG is 8,000 ppmw (0.8% by weight). The current permit fuel sulfur limits of the turbines are consistent with the applicable federal rule.

### 2.1 PLANT OPERATION DESCRIPTION

The Facility was permitted and built as a peaking facility with a permit limit of 2,300 hours per year per turbine. Each turbine also has a permit limit of 500 hours while operating on distillate oil. Any hours operating on distillate oil also count toward the total annual 2,300 hour limit.

Power plants are dispatched to meet the system electrical load at the lowest possible cost. Therefore, those power plants which operate more efficiently with a lower fuel cost will be dispatched first. Peaking facilities, due to their

limited output and fuel costs, are typically dispatched last, either during extreme weather conditions or limited power availability, thereby limiting the number of run hours a peaking facility will operate over a year.

If the Facility is called to run which is usually a day ahead, it typically runs 6 to 10 hours per operating day. Therefore, the Facility does not maintain firm natural gas service. Calpine is unaware of any facilities that hold a firm natural gas contract for a single peaking power plant.

To alleviate a natural gas shortage event the natural gas provider (Provider) initially issues an Advisory Action which requests users to take various actions to alleviate the situation. If such measures are not sufficient, the Provider next issues Operational Flow Orders (OFOs) mandating specific actions to alleviate the situation. The Provider will interrupt interruptible services if that will restore system flexibility prior to issuance of generally applicable OFOs or curtailments of firm services (examples include: hospitals, residential units, and industries requiring constant gas supply). In the event an OFO is not followed, the Provider will issue a penalty based on the severity of the violation. These penalties are issued to deter violations of the Federal Energy Regulatory Commission (FERC) approved tariff, just as a permitting agency would issue a penalty for a permit violation.

The Facility has been issued or seen the following OFOs over the last three years:

1. No Burn OFO - This OFO requires the facility not to burn natural gas off of the pipeline whether it is available in the pipeline or not;
2. Restricted Buy OFO - This OFO requires the facility to burn less than a determined amount of natural gas over a 24-hour period; and
3. 24-Hour Must Buy OFO - This OFO requires a facility to commit to buying and using a certain rate and total amount of natural gas over a 24-hours period.

Calpine submitted an application in November 2015 to clarify permit language to allow for the Facility to burn distillate oil during OFO periods in addition to when natural gas is completely unavailable. The IEPA is actively working on issuing this construction permit. This will allow for increased opportunity for operating on distillate oil.

The Facility is contracted to be part of the Critical Power infrastructure for the transmission company they provide electricity to. The Facility is contractually obligated to maintain 12 hours of back up fuel (distillate oil) onsite for each turbine in case of emergency.

## 2.2 DISTILLATE OIL TANK ANALYSIS

The Facility has one (1) distillate oil tank that has 960,000 gallons of distillate oil in the tank that supplies fuel to all 3 combustion turbines via a common piping system. The Facility is currently permitted to burn fuel with greater than 480 ppm sulfur until January 1, 2017; however only ultra-low sulfur (ULS) fuel (sulfur content no greater than 15 ppm) has been added to the tank recently due to better availability of ULS fuel. The current sulfur content in the tank is 113 ppm.

When operating on distillate oil, each turbine combusts approximately 14,000 gallons of distillate oil per hour. The distillate oil in the tank would allow for approximately 68.6 hours of turbine operation. Based on projections of future distillate oil use as clarified above, it was determined that the facility would burn approximately 12 hours per year of distillate oil. Therefore, it will take up to five (5) years or until 2022 to reduce the level of distillate oil in the tank to where it could be diluted to 15 ppm.

## 3.0 Nature and Extent of Anticipated Failure

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Section 241.161 (b)(2) states that after January 1, 2017, the sulfur content of all distillate oil used by the fuel combustion emission source must not exceed 15 ppm.

Condition 9b of the most recent draft construction permit states:

*i. Beginning January 1, 2017, the CTs shall not be fired with oil with a sulfur content greater than 0.0015% by weight.*

Condition 15b of the most recent draft construction permit states:

*The Permittee shall sample and analyze for the sulfur content of the fuel for the CTs in accordance with the Federal Acid Rain Program 40 CFR 75.11(d) [refer to Part 75, Appendix D, Section 2.2 and Section 2.3 for fuel oil combustion and pipeline natural gas combustion, respectively] unless it elects to install and operate CEMS for emission of SO<sub>2</sub> from the CTs.*

40 CFR 75, Appendix D allows for 'as delivered', 'daily samples', or 'in storage tank' testing of sulfur content when combusting oil. Historically the Facility has used daily samples/in storage tank to demonstrate compliance with 40 CFR 75 requirements. The most recent in storage tank sample result for sulfur content was 113 ppm.

The distillate oil in the tank would allow for approximately 68.6 hours of turbine operation and the Facility does not anticipate using all of the distillate oil before January 1, 2017. As discussed previously, the Facility is a peaking facility and normally only operates on distillate oil during periods of cold weather when electrical demand is high and the natural gas system is unable to supply enough gas for the CTs to operate. A more detailed description of the operations can be found in Section 2.1.

## 4.0 Immediate Compliance Description

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Immediate compliance with the 15 ppm sulfur limit could be achieved one of two ways; combusting the distillate oil or draining the tank and shipping off site.

### 4.1 COMBUSTION

Per condition 7.1.5 (b)(ii) of the current Clean Air Act Permit Program (CAAPP) permit, distillate oil can only be fired as a backup fuel or for the purposes of shakedown, evaluation of operation and emission testing of the CTs. As stated in Section 3.0 , the Facility normally only operates on distillate oil during periods of cold weather when electrical demand is high and the natural gas system is unable to supply enough gas for the CTs to operate. As mentioned above, peaking plants are dispatched last, so it is difficult to anticipate when the facility would need to operate on fuel oil if natural gas is not available.

There is no maintenance scheduled that would require evaluation of operation for the CTs before the compliance date. Outside of emergency repair situation, it is highly unlikely that the Facility would be able to combust the distillate oil in the storage tank before January 1, 2017.

The Facility is part of the Critical Power infrastructure contractually required to perform readiness testing on natural gas and distillate oil on an annual basis. The length of the readiness testing requirements will not allow for the Facility to combust the remaining distillate oil in the storage tank before January 1, 2017.

If the Facility were permitted to burn the distillate oil in the tank under any circumstances prior to January 1, 2017, it is unlikely that there would be need for the electricity generated by the Facility and Calpine would be operating at a substantial loss. The estimated value of the distillate oil in the storage tank is \$3.8 million. Therefore, combusting the distillate oil when there is not a demand for electricity would be cost prohibitive for Calpine.

### 4.2 SHIPPING OFF SITE

The Facility is not currently equipped to empty the storage tank in any other manner than combustion. The Facility would have to make piping changes,

install pumps, and secondary containment for a loadout area in order to empty the storage tank. These changes are estimated to cost approximately \$250,000.

Additionally, the following Facility plans would need to be reviewed and possibly updated to account for the changes: Stormwater Pollution Prevention Plan (SWPPP), Spill Prevention, Control and Countermeasure plan (SPCC), and Facility Response Plan (FRP). Review of these programs and permits are estimated to cost approximately \$10,000.

The Facility would then need to sell the distillate oil outside of the Illinois market because other stationary sources would be in the same situation as the Facility. The Facility could recoup a portion of their investment in the fuel if it were possible to find a buyer. This option would cost the Facility approximately \$260,000 in physical changes and review, permitting, and training. The amount recouped by selling the fuel would be offset by the cost of refilling the tank with compliant distillate oil.

The Facility is part of the Critical Power infrastructure and is contractually obligated to maintain 12 hours of back up fuel (distillate oil) onsite for each turbine in case of emergency. Therefore, the storage tank cannot be emptied due to contractual obligations. Critical Power suppliers are contracted based on the ability to operate on multiple fuels in the event of an emergency affects one fuel source to the site or other sites that provide electricity to the grid. If an emergency situation occurs during the time the storage tank is being emptied, public safety could be compromised by the Facility's reduced or lack of ability to operate.

#### **4.3 CONCLUSIONS ON IMMEDIATE COMPLIANCE**

Both immediate compliance options would result in significant economic losses for the Facility compared to the compliance plan described in Section 5.0. These losses create an unreasonable hardship for the Facility to immediately comply with the Subpart 214 fuel sulfur limits.



## 5.0 Compliance Plan

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The Facility intends to comply with Section 214.161 (b)(2) and 214.162(d) similar to the description for other existing electrical generating units found in Section 214.161 (c) and (d). The Facility proposes the following:

1. From the date of variance issuance, the Permittee shall not purchase distillate oil for combustion in the CTs exceeding 15 ppm sulfur content;
2. From January 1, 2017 through December 31, 2021, the sulfur content of all distillate oil combusted by the CTs shall not exceed 115 ppm sulfur content;
3. On or after January 1, 2022, the sulfur content of all distillate oil combusted by the CTs shall not exceed 15 ppm sulfur content;
4. The Permittee shall maintain records demonstrating compliance with the requirements in this section (1-3), such as records from the fuel supplier indicating the sulfur content of the distillate oil;
5. The Permittee shall submit copies of the records in subsection 4, along with the test results of the sulfur content of the distillate oil by May 1, 2021;
6. Retain the records for at least 5 years, and provide copies of the records to the Agency within 30 days after receipt of a request by the Agency; and
7. Notify the Agency within 30 days after discovery of deviations from any of the requirements in this subsection (1-5). At minimum, and in addition to any permitting obligations, the notification must include a description of the deviations, a discussion of the possible cause of the deviations, any corrective actions taken, and any preventative measures taken.

This schedule will allow the Facility to operate the CTs on distillate oil as market conditions allow and minimize the potential loss that would be incurred due to immediate compliance as described in Section 4.0. 115 ppm was chosen to account for normal variation of lab analysis.

The estimated cost to achieve compliance through the compliance plan as described would be no greater than the current operating costs for the Facility.

## 6.0 Environmental Impact of Variance

The impacts for the proposed variance are limited to air quality. The emissions and ambient air quality impacts are discussed in this section.

### 6.1 EMISSIONS IMPACTS

The change in emission from the current permit limit of 480 ppm sulfur to 115 ppm and 15 ppm are summarized in Table 6.1-1 below. A summary of the calculations for the limited annual potential to emit for each scenario is included below:

1. The limited potential to emit for 480 ppm (i.e. permitted limit until January 1, 2017) sulfur distillate oil is based on the annual operating limit of 500 hours per turbine on distillate oil and the remaining 1,800 hours on natural gas.
2. The limited potential to emit for 115 ppm (i.e. limit after January 1, 2022) sulfur distillate oil is based on the annual operating limit of 2,300 hours on natural gas as the worst case emissions for SO<sub>2</sub> for this scenario are based on the units burning natural gas.
3. The limited potential to emit for the 115 ppm sulfur distillate oil (i.e. requested variance from January 1, 2017 to January 1, 2022) is based operating hours allowed by the remaining distillate oil in the storage tank (68.6 hours) and the remaining allowable operating hours on natural gas (2,231.4 hours).

Copies of the calculations used to populate the table below are included in Appendix D.

**Table 6.1-1 Emissions Summary**

Scenario	Distillate Oil Sulfur Content Limit ppm	Emission Limit lb/hr	Limited Annual Potential to Emit TPY
Permitted Limit until January 1, 2017 (480 ppm)	480	96.0	78.0
Requested Variance until January 1, 2022 (115 ppm)	115	22.4	14.9
Limit after January 1, 2022 (15 ppm)	15	2.9	14.2

The distillate oil in the tank would allow for approximately 68.6 hours of turbine operation. Using the remaining distillate oil with 115 ppm sulfur content would result in actual emissions of 0.77 tons of SO<sub>2</sub>. This is far below the limited potential to emit for the Facility that goes into effect

January 1, 2017 and is unlikely to occur during the same year; therefore, the impact of the actual SO<sub>2</sub> emissions from using the remaining distillate oil in the storage tank is low.

The most recent construction permit application submitted in November 2015 required SO<sub>2</sub> modeling to be completed to demonstrate that the Facility emissions do not cause or contribute to a violation of the 1-hour, 3-hour, 24-hour, and annual SO<sub>2</sub> National Ambient Air Quality Standard (NAAQS).

## **6.2 AMBIENT AIR QUALITY IMPACTS**

As part of the November 2015 construction permit application, the Agency requested a significant impact level (SIL) analysis be completed for the 1-hour, 3-hour, 24-hour, and annual averaging periods for SO<sub>2</sub>. Calpine included modeling results with the application based on all units operating on distillate oil with a 15 ppm sulfur content. A modeling protocol was submitted on October 2, 2015 and approved on November 23, 2015. Modeling conventions approved in the protocol were followed for this modeling analysis.

The modeled concentrations were compared to the SIL values using high first high (H1H) modeled impacts. Agency modeling guidance requires Prevention of Significant Deterioration (PSD) sources be modeled at 100%, 75%, and 50% load or at specific operations representing full and average loads. Therefore, six operating scenarios were evaluated to determine the worst case concentrations using natural gas and distillate oil with a 15 ppm sulfur content operating conditions at 100%, 75%, and 50% load.

In addition, two startup scenarios were evaluated for the 1-hour averaging period. Startup on natural gas was modeled using the average exhaust flow and temperature from 0% load up to 50% load. The SO<sub>2</sub> emission rates for startup were modeled at the 50% load rate to be conservative. The current permit limits startup time to a maximum of 90 minutes. However, a normal startup period for the CTs is 30 minutes or less. Therefore, the modeled impacts for startup are conservative.

The Facility is not allowed to operate during malfunction or equipment breakdown that would cause a violation of an emission standard; therefore, a malfunction scenario was not modeled.

The most recent SO<sub>2</sub> SIL modeling analysis results based on all unit operated on distillate oil at 15 ppm sulfur content are summarized in Table 6.2-1.

**Table 6.2-1 SO<sub>2</sub> Class II Significant Impact Level Modeling Results for 15ppm Sulfur Distillate Oil**

Operating Scenario	Equipment Operating	Modeled Impact H1H (µg/m <sup>3</sup> ) <sup>1</sup>				Exceed Any SILs?
		1-hour	3-hour	24-hour	Annual	
1	CTs at 100% load on distillate oil	2.70	4.40	1.74	0.008	No
2	CTs at 75% load on distillate oil	2.30	3.95	1.76	0.009	No
3	CTs at 50% load on distillate oil	1.86	2.92	1.46	0.008	No
4	CTs at 100% load on natural gas	3.89	<b>6.45</b>	<b>2.67</b>	0.012	No
5	CTs at 75% load on natural gas	3.22	5.65	2.55	<b>0.013</b>	No
6	CTs at 50% load on natural gas	2.71	4.20	2.11	0.013	No
7	CTs starting up on natural gas	<b>4.64</b>	NA	NA	NA	No
8	CTs starting up on distillate oil	3.13	NA	NA	NA	No

<sup>1</sup> SO<sub>2</sub> SILs are 7.5, 25, 5, and 1 µg/m<sup>3</sup> for the 1-hour, 3-hour, 24-hour, and annual averaging periods, respectively.

**Bold** concentration indicated the worst case scenario.

Based on the results above, no further SO<sub>2</sub> modeling was required as the pollutants concentrations for all averaging periods were less than the SIL when operating on natural gas or distillate oil with 15 ppm sulfur content.

Additional modeling was conducted for this proposed variance to demonstrate the environmental impact of using distillate oil with 115 ppm sulfur content. The additional modeling was conducted using the same parameters as approved as described above, except for an increase in SO<sub>2</sub> emission rate. A SIL analysis based on a sulfur content of 115 ppm was completed for the 1-hour, 3-hour, 24-hour, and annual averaging periods for SO<sub>2</sub>. The modeled concentrations were compared to the SIL values using H1H modeled impacts.

As stated above, the distillate oil in the tank would allow for approximately 68.6 hours of turbine operation and would not allow for 24-hours of operation of all three CTs, so the modeled impacts for the 24-hour and annual averaging periods are overestimations.

Operating scenarios 9-12 modeled impacts are based on a sulfur content of 115 ppm and are summarized in Table 6.2-2.

**Table 6.2-2 SO<sub>2</sub> Class II Significant Impact Level Modeling Results for 115 ppm Sulfur Distillate Oil**

Operating Scenario	Equipment Operating	Modeled Impact H1H ( $\mu\text{g}/\text{m}^3$ ) <sup>1</sup>				Exceed Any SILs?
		1-hour	3-hour	24-hour	Annual	
9	CTs at 100% load on distillate oil	<b>20.75</b>	13.22	13.37	0.059	Yes
10	CTs at 75% load on distillate oil	17.51	<b>30.32</b>	<b>13.55</b>	<b>0.067</b>	Yes
11	CTs at 50% load on distillate oil	8.72	22.40	11.19	0.065	Yes
12	CTs starting up on distillate oil	15.58	NA	NA	NA	Yes

<sup>1</sup> SO<sub>2</sub> SILs are 7.5, 25, 5, and 1  $\mu\text{g}/\text{m}^3$  for the 1-hour, 3-hour, 24-hour, and annual averaging periods, respectively.

**Bold** concentration indicated the worst case scenario.

The results indicate the Facility could potentially contribute to an exceedance of the 1-hour, 3-hour, and 24-hour SO<sub>2</sub> NAAQS due to exceeding the SIL at offsite receptors. However, all of the modeling scenarios demonstrate that the Facility does not cause a modeled NAAQS exceedance by itself.

**Table 6.2-3 SO<sub>2</sub> SIL Modeling Results Compared Against NAAQS Limits**

Averaging Period	Worst Case Modeled Impact ( $\mu\text{g}/\text{m}^3$ )	NAAQS Limit ( $\mu\text{g}/\text{m}^3$ )	Percent of NAAQS
1-hour	20.75	196	10.6%
3-hour	30.32	1,300	2.3%
24-hour	13.55	365	3.7%
Annual	0.067	80	0.1%

As previously stated, the remaining distillate oil in the storage tank would not allow for 24-hours of operation of all three CTs, so the modeled impacts for the 24-hour and annual averaging periods are overestimations. The modeling results for the 1-hour and 3-hour averaging periods exceed the SIL, but the results are far below the NAAQS. All of the receptors with H1H impacts exceeding the SIL are within 580 feet of the Facility fence line and would not contribute to an exceedance of the NAAQS except in this area. The impact on ambient air quality from using the remaining distillate oil in the storage tank are low.

The nearest SO<sub>2</sub> monitoring sites are Cicero (AQS ID 17-031-4002) and Northbrook (AQS ID 17-031-4201) located approximately 57 and 23 miles from the Facility, respectively. Neither of which recorded any exceedances in 2013 (IEPA 2013). The highest 1-hour samples in 2013 for Cicero and Northbrook are 14 and 10 ppb (36.7 and 26.2 ug/m<sup>3</sup>), respectively, and are well below the 1-hour SO<sub>2</sub> NAAQS of 75 ppb (196 ug/m<sup>3</sup>). Based on the SIL modeling results, the Facility is not contributing to these monitors.

The Facility is approximately 56 miles from the nearest nonattainment area for the 1-hour SO<sub>2</sub> NAAQS, Lemont (AQS ID 17-031-16010). Based on the SIL modeling results, the Facility is not contributing to this monitor.

### **6.3 CONCLUSIONS ON IMPACTS**

The distillate oil in the tank would allow for approximately 68.6 hours of turbine operation or approximately 22.8 hours for each CT. Based on projections of future distillate oil use, it was determined that the Facility would burn distillate oil approximately 12 hours per year for all units combined and could take up to five (5) years or until 2022 to use all of the remaining distillate oil in the storage tank. This operating projection is an increase over historical operations, but well below the hours of operation and potential to emit limits allowed by the Facility's air permit.

Modeling of the requested variance sulfur content of 115 ppm does indicate an exceedance of the SO<sub>2</sub> SILs, but the impacts are localized and well below the NAAQS.

Based the limited hours that the CTs can operate on the remaining distillate oil in the storage tank and the actual sulfur content of the fuel, there will be low environmental impacts from allowing the Facility to combust the 960,000 gallons of 115 ppm sulfur distillate oil remaining in the storage tank.

## 7.0 Supporting Document Citations

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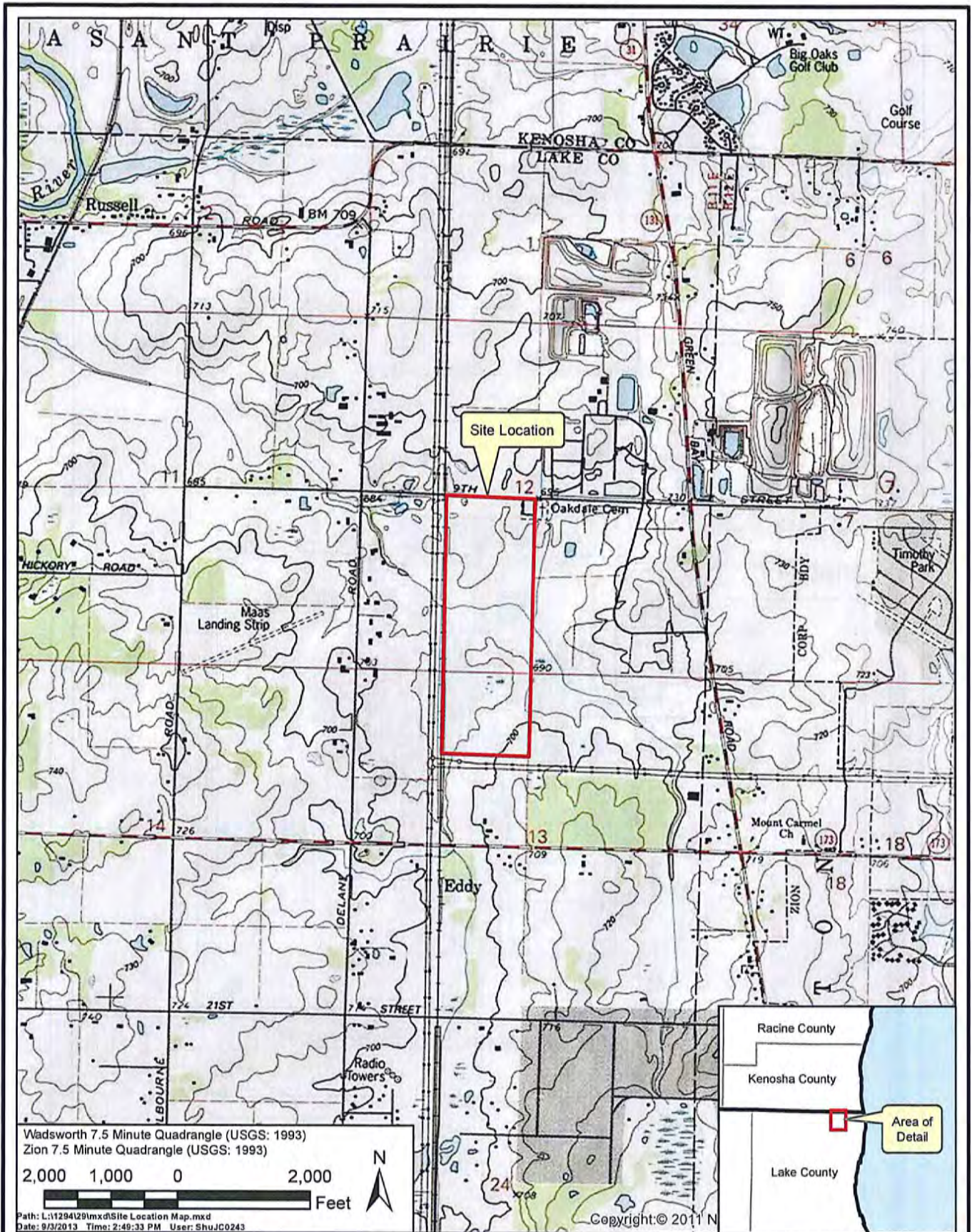
State of Illinois, Illinois Environmental Protection Agency, Air Quality Report 2013,  
<http://www.epa.state.il.us/air/air-quality-report/2013/air-quality-report-2013.pdf>

## Appendix A


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Figures





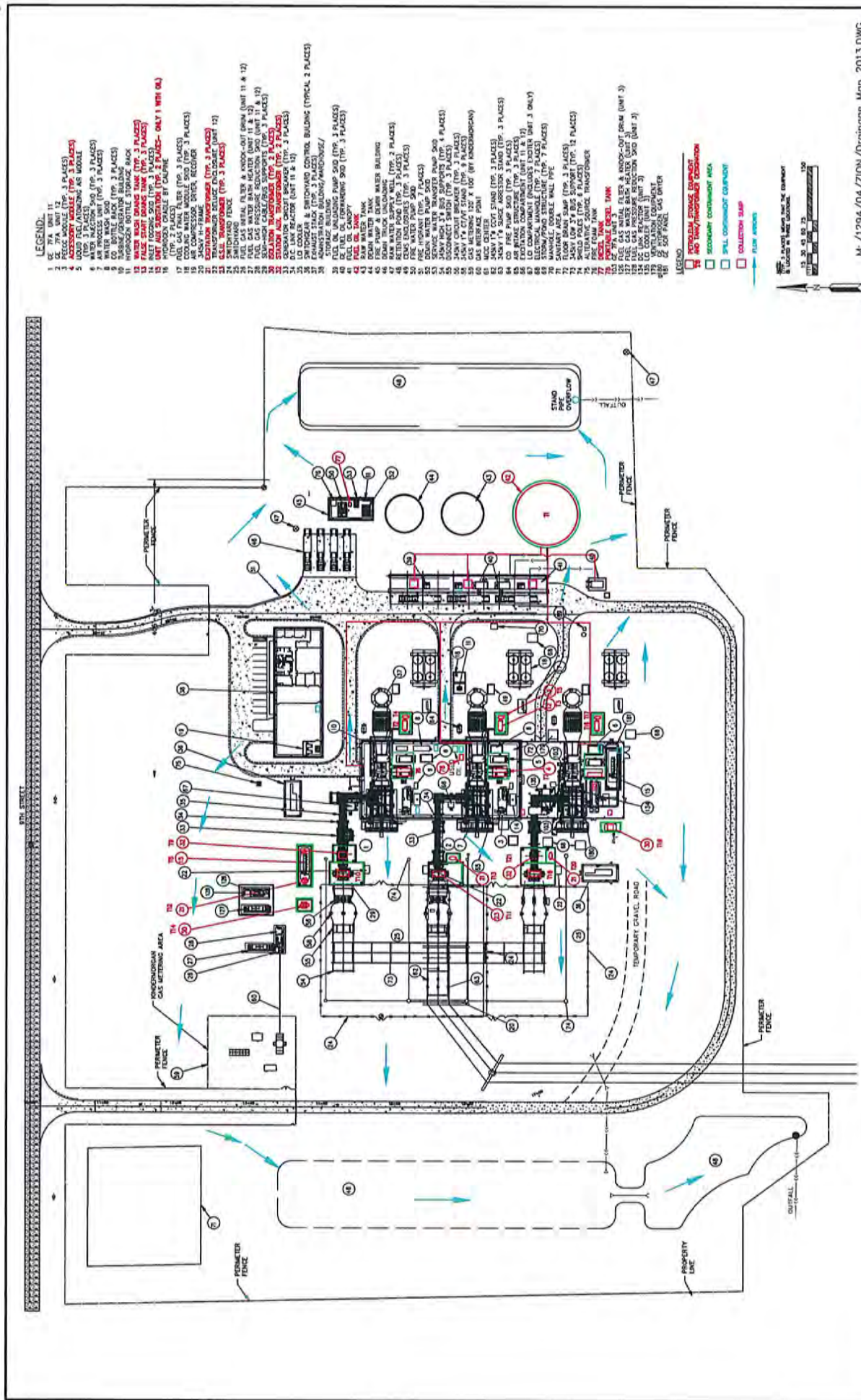
**CALPINE - ZION ENERGY CENTER**  
**Site Location Map**

  
 Engineers - Scientists  
 Business Professionals  
 www.wenck.com

**Wenck**  
 1800 Pioneer Creek Center  
 Maple Plain, MN 55359-0429  
 1-800-472-2232

**SEPT 2013**  
**Figure 1**





**LEGEND:**

- 1 0.5" DIA. UNIT 11
- 2 0.5" DIA. UNIT 12
- 3 0.5" DIA. UNIT 13
- 4 **ADDITIONAL STORAGE TANK (TP, 3 PLACES)**
- 5 **LIQUID FUEL/ATMOSPHERIC AIR MIXER**
- 6 **WATER REACTION SMO (TP, 3 PLACES)**
- 7 **WATER REACTION SMO (TP, 3 PLACES)**
- 8 **WATER REACTION SMO (TP, 3 PLACES)**
- 9 **CO. BOTTLE BANK (TP, 2 PLACES)**
- 10 **HYDROGEN BOTTLE STORAGE BANK**
- 11 **WATER BUSH DRAINAGE TANK (TP, 2 PLACES)**
- 12 **WATER BUSH DRAINAGE TANK (TP, 2 PLACES)**
- 13 **UNIT FLOORING SMO (TP, 3 PLACES)**
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**LEGEND:**

- 1 **POTENTIAL STORAGE CAPACITY**
- 2 **NO. OF 100% THROUGHPUT CAPACITY**
- 3 **SECURITY CONTOUR AREA**
- 4 **SPILL CONTOUR AREA**
- 5 **COLLECTION SUMP**
- 6 **FLOW ARROWS**

MT. /1294/04/ZION/Drainage Map 2013.DWG



Wenck Associates, Inc.  
1600 Pioneer Creek Center  
Environmental Engineers  
Mont Pelic, Me. 05559

SEPT. 2013  
FIGURE 3

CALPINE - ZION  
Site Drainage Map

## Appendix B

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Copy of Draft Construction Permit (APPLICATION ID# 99110042)

217/785-1705

CONSTRUCTION PERMIT - PSD APPROVAL - NSPS - REVISED

PERMITTEE

Zion Energy L.L.C.  
Attn: ~~David Plauek~~ Glenn Calloway, Plant Manager  
5701 Ninth Street  
Zion, Illinois 60099

Application No: 99110042                      I.D. No.: 097200ABB  
Applicant's Designation: ZIONENERGY  
Subject: Electricity Generating Peaking Station  
Initial Date Issued: December 8, 2000  
Date Revision Request Received: November 25, 2015  
Date Revision Issued:  
Location: West Ninth Street, Zion, Lake County

Permit is hereby granted to the above-designated Permittee to CONSTRUCT emission unit(s) and/or air pollution control equipment consisting of three simple cycle combustion turbines with distillate oil as back-up fuel, two fuel heaters, and a fuel oil storage tank as described in the above referenced application and summarized in Attachment A. This Permit is granted based upon and subject to the findings and special conditions that follow:

In conjunction with this permit, approval is given with respect to the Prevention of Significant Deterioration of Air Quality Regulations (PSD) to construct the above referenced project, in that the Illinois Environmental Protection Agency (Agency) finds that the application fulfills all applicable requirements of 40 CFR 52.21. This approval is issued pursuant to the Clean Air Act, as amended, 42 U.S.C. 7401 et. seq., the Federal regulations promulgated thereunder at 40 CFR 52.21 for Prevention of Significant Deterioration of Air Quality (PSD), and a Delegation of Authority agreement between the United States Environmental Protection Agency and the Illinois EPA for the administration of the PSD Program. This approval becomes effective in accordance with the provisions of 40 CFR 124.15 and may be appealed in accordance with the provisions of 40 CFR 124.19. This approval is also based upon and subject to the following findings and conditions:

Findings for Revised Permit

1. Zion Energy L.L.C. (Zion Energy) operates a peaking power station with three combustion turbines and the ability to generate up to about 480 MW (nominal) of electricity. The primary fuel for the turbines is natural gas. Distillate oil is the backup fuel.
- 2a. Zion Energy has requested a revised permit that clarifies the scope of the term "natural gas curtailment" which is relevant to periods when backup oil is fired, given changes in the practices of natural gas suppliers.

- b. Zion Energy also requested that the limit for the sulfur content of oil be lowered to now reflect use of ultra-low sulfur diesel, with associated reductions in permitted SO<sub>2</sub> emissions.
3. The Illinois EPA has determined that the requested changes to the permit would still comply with all applicable Illinois Air Pollution Board Regulations and the federal Prevention of Significant Deterioration of Air Quality Regulations (PSD), 40 CFR 52.21.
4. The permit was previously revised in 2005. Provisions were removed that were no longer applicable because certain units addressed by the original permit were not constructed. The limits for sulfur content of oil were also lowered, with associated reductions in permitted SO<sub>2</sub> emissions.
5. A copy of the application for revised permit, the project summary and a draft of this revised permit were placed in a location in the vicinity of the project, and the public was given notice and an opportunity to examine this material and to submit comments.

The Illinois EPA is issuing this revised permit for the project subject to the following special conditions and consistent with the specifications and data included in the applications. Any departure from the conditions of this approval or terms expressed in the applications would need to receive prior written authorization from Illinois EPA.

#### Conditions

1. Standard conditions for issuance of construction permits, attached hereto and incorporated herein by reference, shall apply to this project, unless superseded by the following special conditions.
- 2a. The fuels fired at the facility shall be only natural gas and distillate oil, as defined in 40 CFR 60.41c.
- b. Distillate oil shall only be fired as a backup fuel, that is:
  - i. For purposes of shakedown, evaluation of operation and emission testing of emission units; and
  - ii. At other times when and to the extent that circumstances, such as natural gas supply curtailments, including issuance of advisory action orders and operational flow orders by the provider of natural gas, or breakdown of natural gas delivery systems that are beyond the control of the Permittee that ~~direct the Permittee not to fire natural gas effectively~~ makes it impossible for the Permittee to fire natural gas in one or more emission units. However, this requirement does not require that a unit, once operating on oil, be shutdown if natural gas becomes available for the unit during a day if the unit would then be restarted with natural gas on that same day.

- 3a. The combustion turbines (CT) shall each be equipped, operated, and maintained with low NO<sub>x</sub> combustors for natural gas firing and water injection (WI) for oil firing.
- b. i. Operation of the CTs (3 units) shall not exceed a combined total of 6,900 hours per year. Operation of each individual CT shall not exceed 3,300 hours in any single year and 2,300 hours averaged over any three consecutive years.
- ii. Operation of each CT when firing on backup fuel (distillate fuel oil) shall not exceed 500 hours per year.
- iii. If at any time, the operation of an individual CT exceeds 2,300 hours in a year, the Permittee shall demonstrate that operation of such CT was consistent with its use as a peaking turbine, by making a detailed submittal of information to the Illinois EPA within 2 months that includes the following:
- A. The total hours that the CT actually operated during such year and a summary of actual operating hours of the CT for prior years;
- B. A description of the circumstances that contributed to actual operation for more than 2,300 hours in a year, with supporting documentation, including:
1. The circumstances with respect to the public demand for power, e.g., unusually cold or hot weather;
  2. The circumstances with respect to unavailability of other CTs at the facility, e.g., unanticipated or extended outage of CTs;
  3. The circumstances with respect to electric utility need for power, e.g., unexpected outages of major generating units or damage to power transmission systems;
  4. Other circumstances that the Permittee believes contributed to the operation of the CT for more than 2,300 hours in a year; and
- C. Further information to demonstrate that the above circumstances are uncommon or unlikely to reoccur so as to result in actual operation of the CT for more than 2,300 hours in a year.
- iv. Prior to operation of an individual CT for more than 2,300 hours in a year in a manner that is inconsistent with its use as a peaking turbine, the Permittee shall obtain a revised permit allowing such operation pursuant to PSD, 40 CFR 52.21, which permit may establish additional requirements for the CT as are appropriate as Best Available Control Technology.

- v. For the purposes of this permit, peaking operation means operation when base load generating capacity is insufficient to meet electrical demand and operating reserve requirements, due to high demand, outage of base load generating units, restrictions or interruptions in the power grid, etc. It also includes operation of a unit for purposes of verifying unit availability for the above purposes. Compliance with this requirement shall be presumed for an individual CT if it operates for no more than 2,300 hours per year.

The above limitations on operation are intended to assure that the facility is operated as a natural gas fired peaking facility, with distillate oil used as a backup fuel.

- c. i. The emissions of NO<sub>x</sub> from each CT when firing natural gas shall not exceed 9 ppmdv at 15% O<sub>2</sub> on an hourly average.
- ii. These emission limits do not apply during periods of startup and shutdown as addressed by Condition 4. Compliance with these limits shall be demonstrated during the shakedown period as provided in Condition 11(a).
- d. The emissions of NO<sub>x</sub> from a CT when firing backup fuel (i.e. distillate fuel oil) shall not exceed 42 ppmdv at 15% O<sub>2</sub> on an hourly average.
- e. Each CT shall use good combustion practices to reduce emissions of CO and PM, which practices shall include routine operating practices, maintenance and repair practices, and other periodic assessments of the combustion performance of the CT to reasonably minimize emission of CO and PM.
- f. The emissions of CO and PM from each CT shall comply with the limits specified in Table 1A and 1B of the attachment B.
- g. i. The CTs shall not be fired with oil with a sulfur content greater than 0.0015% by weight. (also see Condition 9(b))

Please see additional discussion below in Condition 9(a) and (b).

~~TRANSITION LANGUAGE TO BE DISCUSSED~~

- 4. Each CT shall be operated in a manner consistent with good air pollution control practices to minimize emissions during startup and shutdown including:
  - a. The Permittee shall manage the operation of the CTs to minimize multiple startups of a CT in a single day, unless startup is tripped off, and to provide adequate time to follow the procedures for normal startup of the CTs, except for requests for immediate delivery of power as would result from unexpected loss of a transmission line or other generating capacity.
  - b. Operation in accordance with the manufacturer's written instructions or other written instructions developed and maintained by the Permittee that shall include at a minimum the following measures:



Review of operating parameters of the CT during startup or shutdown as necessary to make adjustments to reduce or eliminate excess emissions.

Implementation of inspection and repair procedures for a CT prior to attempting startup following repeated trips.

- c. The Permittee shall maintain each CT in accordance with written procedures developed and maintained by them. These procedures shall be reviewed at least annually and enhanced consistent with good air pollution control practice based on actual operating experience and performance of the CTs.
- 5a. Each fuel heater shall be equipped with low-NO<sub>x</sub> burners designed to emit no more than 0.15 lb NO<sub>x</sub>/million Btu heat input on an hourly average.
  - b. Each fuel heater shall be maintained and operated with good combustion practices to control emissions of CO and PM.

Conditions 3, 4, and 5 represent the application of the Best Available Control Technology as required by Section 165 of the Clean Air Act.

6. Reserved

- 7a. The gas CTs are subject to the New Source Performance Standard (NSPS) for Stationary Gas Turbines, 40 CFR 60, Subpart A and GG. The Illinois EPA is administering NSPS in Illinois on behalf of the United States EPA under a delegation agreement. In addition to complying with other applicable emission standards, each CT must comply with the applicable emission standards of the NSPS, as follow:
    - i. The NO<sub>x</sub> emissions from each CT shall not exceed the limit established by the NSPS, pursuant to 40 CFR 60.332 (a) (1).
    - ii. The emission from each CT shall not contain SO<sub>2</sub> in excess of 0.015 percent by volume at 15 % O<sub>2</sub> on a dry basis or the CTs shall not burn any fuel which contains sulfur in excess of 0.8 percent by weight, pursuant to 40 CFR 60.333 (a) and (b).
  - b. Not applicable (Condition previously addressed auxiliary boilers)
  - c. The fuel oil storage tank is subject to the New Source Performance Standard (NSPS) for storage vessels, 40 CFR 60, Subpart A and Kb. The Illinois EPA is administering NSPS in Illinois on behalf of the United States EPA under a delegation agreement.
  - d. At all times, the Permittee shall maintain and operate the CTs and the fuel oil storage tank in a manner consistent with good air pollution control practice for minimizing emissions, pursuant to the NSPS, 40 CFR 60.11(d).
8. The emission of smoke or other particulate matter from each CT shall not have an opacity greater than 30 percent, pursuant to 35 IAC 212.123(a), except as allowed by 35 IAC 201.149, 212.123(b) or 212.124.

- 9a. Emissions from the CT shall not exceed the limits in Table 1A, 1B and 1C of Attachment B.
- b. i. Beginning January 1, 2017, the CTs shall not be fired with oil with a sulfur content greater than 0.0015% by weight.
- ii. Prior to January 1, 2017, the CTs shall not be fired with oil with a sulfur content greater than 0.048% by weight.
- c. Emissions of NO<sub>x</sub> from each fuel heater shall not exceed 2.25 lb/hr and 2.59 tons/yr.
- d. Compliance with the above annual limits shall be determined from a running total of 12 months of data.
- 10a. This permit is issued based on the source not being a participating source or new participating source under the Emission Reduction Market System (ERMS), 35 IAC Part 205, because its VOM emissions during each seasonal allotment period are less than 10 tons. This reflects an expectation that actual VOM emissions will be much less than allowed by this permit.
- b. The Permittee shall become subject to the ERMS as a new participating source if the VOM emissions from the source are 10 tons or greater in any seasonal allotment period. In such case, the Permittee shall hold Allotment Trading Units (ATU) for its seasonal emissions in accordance with 35 IAC 205.150(c)(1) and 205.720, beginning with the following seasonal allotment period. For this purpose, the source's VOM emissions shall be determined by the methods and procedures specified in this permit or the Clean Air Act Permit Program (CAAPP) permit for the source.
- c. The Permittee shall promptly notify the Illinois EPA if the source's VOM emissions are 10 tons or greater in a season [see also Condition 16(h)(v)]. By December 31 of the first year in which seasonal VOM emissions are 10 tons or greater, the Permittee shall submit a request for a revision to this construction permit or the source's CAAPP permit to address applicable requirements of the ERMS. This request shall include a certification acknowledging that it will be required to hold ATUs by the end of each reconciliation period and an explanation of the means which it plans to obtain ATUs. [35 IAC 205.310(a) and (g)]
- 11a. Under this permit, each CT may be operated for a period of up to 180 days from initial startup to allow for equipment shakedown and emissions testing as required. This period may be extended by the Illinois EPA upon request of the Permittee if additional time is needed to complete shakedown or perform emission testing, provided however that an hourly NO<sub>x</sub> emission limit representing 15 ppm<sub>dv</sub> NO<sub>x</sub> @ 15% O<sub>2</sub> (equivalent to 0.062 lb/mmBtu) shall apply during such extended shakedown for CT operation.
- b. Upon successful completion of emission testing demonstrating compliance with applicable limitations, the Permittee may continue to operate the facility as allowed by Section 39.5 (5) of the Environmental Protection Act.

c. This condition supersedes Standard Condition 6.

12a. i. Within 60 days after operating a CT at the greatest load at which it will normally be operated but not later than 180 days after its initial startup, the Permittee shall perform emissions tests of the CTs as follows. Emissions shall be measured by an approved testing service during conditions which are representative of maximum emissions (peak load) for NO<sub>x</sub>, CO, PM, VOM, and opacity and also at the minimum normal operating load, and two intermediate load levels for NO<sub>x</sub>, for firing both natural gas and distillate oil.

ii. The Permittee shall perform emission tests within 45 days of a written request by the Illinois EPA. The Illinois EPA will require these tests if, based on observations by Field personnel, units are poorly maintained or operated so as to make compliance with permit limitations uncertain.

iii. Any extension to these time periods that may be provided at its discretion by the Illinois EPA shall not alter the Permittee's obligation to perform emission testing for purpose of the NSPS in a timely manner as specified by 40 CFR 60.8.

b. i. The following USEPA methods and procedures shall be used for testing of emissions:

Location of Sample Points	USEPA Method 1
Gas Flow and Velocity	USEPA Method 2
Flue Gas Weight	USEPA Method 3 or 3A
Moisture	USEPA Method 4
Particulate Matter	USEPA Method 5
Nitrogen Oxides	USEPA Method 20 or 7 or 7E
Opacity	USEPA Method 9
Carbon Monoxide	USEPA Method 10
Volatile Organic Material	USEPA Method 18 or 25A
PM <sub>10</sub>	USEPA Method 201 or 201A (40 CFR 51, Appendix M)

The Permittee may report all PM emissions measured by USEPA Method 5 as PM<sub>10</sub>, including back half condensable particulate. If the Permittee reports USEPA Method 5 PM emissions as PM<sub>10</sub>, testing using USEPA method 201 or 201A need not be performed.

ii. Measurements for NO<sub>x</sub> from the CTs shall be conducted in accordance with 40 CFR 60.335, as specified below, unless alternative testing procedures are approved by USEPA pursuant to 40 CFR 60.8(b):

A. The NO<sub>x</sub> emissions shall be computed for each run using the equation in 40 CFR 60.335(c)(1).

B. The span values for Method 20 shall be 300 ppm of NO<sub>x</sub> and 21 percent O<sub>2</sub>, pursuant to 40 CFR 60.335(c)(3).

C. The NO<sub>x</sub> emissions shall be determined at four points in the normal operating range of the CTs, including the minimum

point in the range and peak load, pursuant to 40 CFR 60.335(c)(2).

- D. All loads shall be corrected to ISO conditions using the appropriate equations supplied by the manufacturer, pursuant to 40 CFR 60.335(c)(2).
- iii. Measurements for other pollutants shall be conducted as follows:
- A. CO, PM and VOM concentrations shall be measured at peak, intermediate and minimum CT load.
  - B. PM emissions measured by USEPA Method 5, including back half condensable particulate, may be provided as an alternative to measurement of PM<sub>10</sub> emissions using USEPA Method 201 or 201A.
  - C. Measurements for organic hazardous air pollutants in the VOM (e.g., formaldehyde, toluene, acetaldehyde, and acrolein) shall be provided, if VOM emissions are measured by Method 18. (See also Condition 12(c)(iii))
  - D. Unless continuous emissions monitoring is conducted for the particular pollutant, measurements shall also be performed for emissions of NO<sub>x</sub>, CO and VOM during startup of a CT, in accordance with a plan approved by the Illinois EPA. For purposes of these measurements, as approved by the Illinois EPA, the Permittee may adapt USEPA Reference Test Methods as necessary to address the short duration and transient conditions of startups.
- c. At least 60 days prior to the actual date of testing, a written test plan shall be submitted to the Illinois EPA for review. This plan shall describe the specific procedures for testing and shall include as a minimum:
- i. The person(s) who will be performing sampling and analysis and their experience with similar tests;
  - ii. The specific conditions under which testing shall be performed including a discussion of why these conditions will be representative of maximum emissions and the means by which operating parameters will be tracked and recorded;
  - iii. The specific determinations of emissions that are intended to be made, including sampling and monitoring locations, the test method(s) that will be used, with the specific analysis method, if the method can be used with different analysis methods; and identification of any organic hazardous air pollutants that will be measured. As part of this plan, the Permittee may set forth a strategy for performing emission testing of selected CTs provided that all units are fitted for testing, the identity of the units to be tested are determined immediately before testing by the Illinois EPA or otherwise randomly, and continuous emission monitoring of NO<sub>x</sub> is present on all CTs. The Permittee may also propose a plan for testing across the normal operating range of the CTs; and

- iv. The proposed plans for testing emissions during startup of a CT as required by Condition 12(b)(iii)(D), including the number of startups for which measurements will be performed; the procedures that will be followed for startup of the CT; the approach that will be generally followed to assure that measurements can be conducted for and will be representative of the startup period; any proposed adaptations to reference test methods; and any other significant considerations for testing of emissions during startup.
- d. The Illinois EPA shall be notified prior to these tests to enable the Illinois EPA to observe these tests. Notification for the expected date of testing shall be submitted a minimum of 30 days prior to the expected date. Notification of the actual date and expected time of testing shall be submitted a minimum of 5 working days prior to the actual date of the test. The Agency may at its discretion accept notifications with shorter advance notice, although the Illinois EPA will not accept such notifications if they interfere with the Illinois EPA's ability to observe testing.
- e. Three copies of the final reports for emission tests shall be forwarded to the Compliance Section in Springfield within 30 days after the test results are compiled and finalized. The final report from testing shall contain a minimum:
  - i. A summary of results.
  - ii. General information.
  - iii. Description of test method(s), including a description of sampling points, sampling train, analysis equipment, and test schedule.
  - iv. Detailed description of test conditions, including:
    - A. Fuel consumption (standard ft<sup>3</sup>);
    - B. CT firing rate (million Btu/hr);
    - C. CT/Generator output rate (MWe); and
    - D. Water injection rate during backup fuel firing.
  - v. Data and calculations, including copies of all raw data sheets and records of laboratory analysis, sample calculations, and data on equipment calibration.
- 13a. The Permittee shall install, operate, and maintain monitors to measure and record fuel consumption by each CT.
  - b. The Permittee shall install, operate, and maintain monitors on each CT to measure and record the ratio of water to fuel when firing backup fuel.
- 14a. i. To demonstrate compliance with the NO<sub>x</sub> limits of this permit, the Permittee shall install, operate, and maintain a Continuous Emissions Monitoring (CEM) system on each CT to measure emissions of NO<sub>x</sub>. The applicable procedures under 40 CFR 60.13, 60.47a(c) and 75.12 shall be followed for the installation, evaluation, and operation of this NO<sub>x</sub> CEM system. These monitoring systems shall be operational through startup and shutdown of the CTs.

- ii. At least 30 days prior to initial startup of each CT, the Permittee shall submit a detailed monitoring plan to the Illinois EPA for review and comment. This plan shall describe the configuration and operation of the CEM system for each CT, including NO<sub>x</sub>, diluents and exhaust flow monitoring devices.
  - iii. These monitoring systems shall be operated and collect data in accordance with the applicable provisions of the Acid Rain Program.
- b. Notwithstanding the above conditions of the permit specifying monitoring practices, other credible evidence may be used to establish compliance or noncompliance with applicable emission limits.
- 15a. The Permittee shall sample and analyze for the sulfur content of the fuel for the CTs in accordance with the Federal Acid Rain Program 40 CFR 75.11(d) [refer to Part 75, Appendix D, Section 2.2 and Section 2.3 for fuel oil combustion and pipeline natural gas combustion, respectively] unless it elects to install and operate CEMS for emission of SO<sub>2</sub> from the CTs.
- b. Sampling and analysis for the fuel nitrogen content of the fuel for the CTs is not required as a condition of this permit as continuous emission monitoring for NO<sub>x</sub> emissions is required by Condition 14.
- c. The above provisions establish a custom schedule for determination of sulfur content and nitrogen content of fuel, subject to case-specific approval by USEPA pursuant to 40 CFR 60.13(i), in which approval USEPA may establish additional requirements upon the Permittee for sampling and analysis of fuel. If USEPA does not approve a custom schedule for the CTs, the Permittee shall also sample and analyze for sulfur and nitrogen content of the natural gas and distillate oil being fired in the CTs in accordance with 40 CFR 60.334(b).
- 16a. The Permittee shall maintain a file of the following items:
- i. The written instructions being followed by the Permittee as good combustion practices and good air pollution control practice to minimize emission in accordance with Conditions 3(e), 4 and 5(b);
  - ii. The heat content of each of the fuel fired in the CTs (Btu/standard ft<sup>3</sup> or Btu/gallon);
  - iii. The composition of fuel as determined in accordance with Condition 15;
  - iv. For the life of fuel oil storage tank, the dimensions of the tank and an analysis showing the capacity of the tank;
  - v. The Sulfur content of backup fuel (weight %); and
  - vi. A copy of the Final Report(s) for emission testing conducted pursuant to Condition 12.

- b. The Permittee shall maintain the following daily operating records for the CTs:
  - i. The quantity of fuel consumed for each CT (standard ft<sup>3</sup> or gallons);
  - ii. Total CT-operating hours and number of startups for each CT;
  - iii. Facility operating hours on a daily basis. For this purpose, the Permittee shall consider the facility to operate for one hour if one or more CTs are operated during an hour. For example, if one CT or four CTs operate from 12:00 noon to 6:00 PM on a day, in both cases, this shall count as six operating hours;
  - iv. Each period when a CT was fired on backup fuel, with the reason(s) for use of backup fuel and supporting documentation along with water usage in the WI control system (gal/day); and
  - v. Each period when a CT operates when the ambient temperature is less than or equal to 59°F with ambient temperature, by hour, for each hour.
- c. The Permittee shall keep inspection, maintenance, and repair logs with dates and the nature of such activities for the following:
  - i. Each CT including combustors and WI system; and
  - ii. Each fuel heater.
- d. Not applicable (Condition previously addressed auxiliary boilers).
- e. The Permittee shall maintain the following records related to each startup of the CTs:
  - i. Date and time of startup;
  - ii. Type of startup, i.e. scheduled or emergency;
  - iii. Whether operating personnel for the CTs or air environmental staff are on site during startup; and
  - iv. A description of the startup, if written operating procedures are not followed during the startup or operating problems occur during the startup, including detailed explanation.
- f. The Permittee shall keep the following operating records for the CTs:
  - i. Total operating hours of each CT (hours/month, hours/year (Calendar year)); and
  - ii. Total operating hours of each CT operated using backup fuel (distillate oil) (hours/year (Calendar year)).
- g. The Permittee shall keep the following records with regard to emissions:

- i. Other data, not addressed above, used or relied upon by the Permittee to determine emissions;
  - ii. NO<sub>x</sub> emissions from each CT recorded hourly, quarterly, and annual (in lb/mmBtu) by combining the NO<sub>x</sub> concentration (in ppm) and diluent concentration (in percent O<sub>2</sub> or CO<sub>2</sub>) measurements according to the procedures in 40 CFR 75 Appendix F;
  - iii. Monthly emissions of NO<sub>x</sub>, CO, SO<sub>2</sub>, VOM, and PM from each CT (ton/month). NO<sub>x</sub> emissions shall be based on data from the CEM. All other emissions shall be calculated based on fuel consumption, relevant factors developed from emission test data and fuel composition, with supporting calculations;
  - iv. Annual facility emissions of NO<sub>x</sub>, CO, SO<sub>2</sub>, VOM, and PM, compiled on at least a monthly basis;
  - v. Average NO<sub>x</sub> emissions in ppm, on a monthly and annual basis, for comparison to the limits in Condition 3(c); and
  - vi. Seasonal emissions of VOM (May through September) from the facility.
- h. The Permittee shall maintain records that identify:
- i. Any periods during which a continuous monitoring system was not operational, with explanation; and
  - ii. Any day in which emissions exceeded an applicable standard or limit.
17. All records required by this permit shall be retained on site for a period of at least 3 years and shall be readily available for inspection and copying by the Illinois EPA upon request.
- 18a. The Permittee shall furnish the Illinois EPA with written notification as follows with respect to commencement of construction and operation of the CTs:
- i. The date construction of the CTs commenced, postmarked no later than 30 days after such date, pursuant to 40 CFR 60.7(a)(1). The notification for the CTs shall be accompanied by a description of the fuel;
  - ii. The anticipated date of initial startup of the CTs, postmarked not more than 60 days nor less than 30 days prior to such date, pursuant to 40 CFR 60.7(a)(2);
  - iii. The actual date of initial startup of the CTs postmarked within 15 days after such date, pursuant to 40 CFR 60.7(a)(3); and
  - iv. The actual date that each CT begins gainful operation, with electricity produced by the CT available for sale at more than the minimum or avoided cost of the purchaser, postmarked within 15 days after such date.



- b. The Permittee shall furnish the Illinois EPA with written notification as follows with respect to firing of backup fuel:
    - i. Use of backup fuel in a CT for more than 72 hour in a rolling 12-month period following completion of shakedown and emission testing; and
    - ii. Use of backup fuel in a CT for a period of more than 6 hours, other than for purposes of shakedown, emission testing or backup fuel system evaluation.
  - c. If there is any exceedance of the requirements of Condition 2 through 9 of this permit that is not addressed in the regular quarterly reports required by Condition 19(a), the Permittee shall submit a written notification to the Illinois EPA's Compliance Unit in Springfield, Illinois within 30 days after the exceedance. The notification shall include a description of the exceedance, a copy of relevant records, and a description of the exceedance or violation and efforts to reduce emissions and future occurrences.
- 19a. The Permittee shall fulfill applicable reporting requirements in the NSPS, 40 CFR 60.7(c) for each CT. For this purpose, the quarterly reports shall be submitted no later than 30 days after the end of the calendar quarter.
- b. In conjunction with the Annual Emission Report required by 35 IAC Part 254, the Permittee shall provide the following information for the preceding calendar year:
    - i. The operating hours of each CT.
    - ii. The operating hours of each CT with distillate fuel.
    - iii. The total number of startups of CTs.
    - iv. The total natural gas and oil consumption of the CTs.
  - c. The Permittee shall comply with applicable reporting requirements under the Acid Rain Program, with a single copy of such report sent to Illinois EPA. This copy shall be sent to the Division of Air Pollution Control, Compliance Unit.
  - d. If the emission testing required by Condition 12(a) (i) and (ii) is not performed within 45 days of beginning gainful operation of a CT, the Permittee shall submit a report summarizing NO<sub>x</sub>, CO and VOM (or hydrocarbon) emissions of the CTs as determined by diagnostic measurements, e.g., combustion gas analyzers, during shakedown of the CTs.
- 20a. Any required reports and notifications concerning equipment operation, emissions testing, or a monitoring system shall be sent to the Illinois EPA at the following address unless otherwise indicated:

Illinois Environmental Protection Agency  
Division of Air Pollution Control

Compliance Unit (#40)  
P.O. Box 19276  
Springfield, Illinois 62794-9276

Telephone: 217/782-5811 Fax: 217/782-6348

- b. One copy of notifications and reports required by this permit that concern emission testing and monitoring shall also be sent electronically to the Illinois EPA, Bureau of Air, Compliance Section, Source Monitoring Unit, using the State of Illinois's File Transfer Website, unless otherwise instructed by the Illinois EPA:

<http://filet.illinois.gov>

Recipient Email Address: EPA.BOA.SMU@illinois.gov  
File Transfer Email Subject: Zion Energy LLC, Zion, ID 097200ABB  
Message to Recipient: "A description of submittal, with date"

- 21a. This permit shall become invalid if construction is not commenced within 18 months after this permit becomes effective, if construction is discontinued for a period of 18 months or more, or if construction is not completed within a reasonable period of time. The 18 month period may be extended by the Illinois EPA upon a satisfactory showing that an extension is justified.
- b. This permit shall become invalid as applied to a particular CT if construction is not commenced as part of commencement of construction of the facility, as addressed above or otherwise, within 18 months after this permit becomes effective, if its construction is discontinued for a period of 18 months or more, or if its construction is not completed within a reasonable period of time.
- c. For purposes of the above provisions, the definitions of "construction" and "commence" at 40 CFR 52.21 (b)(8) and (9) shall apply, which require that a source must enter into a binding agreement for on-site construction or begin actual on-site construction. (Also see the definition of "begin actual construction," 40 CFR 52.21 (b)(11))

This condition reflects provisions of the PSD rules, 40 CFR 52.21(r)(2). This condition supersedes Standard Condition 1.

- 22a. The approval for the above referenced project does not relieve the Permittee of the responsibility to comply with all Local, State and Federal Regulations which are part of the applicable Illinois State Implementation Plan, as well as all other applicable Federal, State, and Local requirements.
- b. This permit does not excuse the Permittee from any new requirements that would be applicable to construction or operation of the CTs based on the timing of their actual installation.

If you have any questions concerning this, please contact Bob Smet at 217/785-9250.

Raymond E. Pilapil.  
Acting Manager, Permit Section

Date Issued:

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Division of Air Pollution Control

REP:RPS:psj

Attachments

cc: Region 1  
Compliance  
USEPA

Attachment A

Significant Emission Units

Unit I.D.	Description	Number	Rated Heat Input <sup>1</sup> (mmBtu/hr)	Control
CT 01 - 03	Simple Cycle Combustion Turbine	3	1,719 <sup>2</sup>	Low NO <sub>x</sub> Combustors or Water Injection, and Good Combustion Practices
FH 01 - 02	Fuel Heater	2	5.7	Good Combustion Practices
ST - 01	Storage Tank <sup>3</sup>	1	---	---

1. Nominal capacity ratings are per unit.
2. Rated heat input when firing on natural gas, when firing on distillate fuel oil the rated heat input is 1928 mmBtu/hr.
3. Distillate fuel oil storage tank, maximum capacity 1.5 million gallon.

Project Emissions (Ton/Year)

Pollutant	Potential Emissions
NO <sub>x</sub>	408.0
CO	134.0
PM/PM <sub>10</sub>	88.6
VOM	14.3
SO <sub>2</sub>	78.0 (14.2)

Attachment B

Table 1A

Hourly Emission Limits for Each CT when Ambient Temperature Greater Than 59°F

Pollutant	Natural Gas		Fuel Oil	
	lb/mmBtu <sup>1</sup>	lb/hr <sup>1,2</sup>	lb/mmBtu <sub>1,3</sub>	lb/hr <sub>1,2,3</sub>
NO <sub>x</sub>	0.037	60.0	0.167	321.0
CO	0.017	29.0	0.034	65.0
PM/PM <sub>10</sub>	0.011	19.0	0.023	44.0
VOM	0.0016	2.8	0.004	7.5
SO <sub>2</sub>	0.0022	3.8	0.047 (0.0015)	90.2 (2.92)

Table 1B

Hourly Emission Limits for Each CT when Ambient Temperature is 59°F or Lower

Pollutant	Natural Gas		Fuel Oil	
	lb/mmBtu <sup>1</sup>	lb/hr <sup>1,2</sup>	lb/mmBtu <sub>1,3</sub>	lb/hr <sub>1,2,3</sub>
NO <sub>x</sub>	0.037	64.0	0.176	340.0
CO	0.018	31.0	0.036	70.0
PM/PM <sub>10</sub>	0.011	19.0	0.023	45.0
VOM	0.0017	3.0	0.004	8.0
SO <sub>2</sub>	0.0024	4.1	0.050 (0.0015)	(2.92)

- Limits based on Low Heating Value (LHV) of fuel, vendor/manufacture data and information provided in the permit application.
- Limits based on modeling data and information provided in the permit application. If the applicable limits for CO or PM/PM<sub>10</sub> are not met by a CT, it shall also be presumed to constitute failure to use good combustion practice as required by Condition 3(e), as well as an exceedance of Condition 3(f).
- The listed SO<sub>2</sub> annual emissions are effective before January 1, 2017. The SO<sub>2</sub> annual emissions listed in parentheses go into effect on January 1, 2017.

Table 1C

Total Annual Emission Limits for CTs<sup>1,2,3</sup>

Pollutant	Ton/Year
-----------	----------

NO <sub>x</sub>	402.8
CO	127.1
PM	84.3
VOM	13.3
SO <sub>2</sub>	77.9 (14.2)

1. The total annual emissions for NO<sub>x</sub>, CO, PM/PM<sub>10</sub>, VOM, and SO<sub>2</sub> are based on total 2,300 hours/year operation including 500 hours/year operation on backup fuel (fuel oil), at the hourly emission rate indicated in Table 1A as peaking turbines operate primarily in summer months.
2. Emissions of NO<sub>x</sub>, CO and VOM during an hour that includes a startup shall be assumed to be at the limits in Table 1A or 1B, as applicable, multiplied by a startup factor (S<sub>ngas</sub>): S<sub>NOX</sub> = 1.25, S<sub>CO</sub> = 7 and S<sub>VOM</sub> = 7 when firing natural gas. Emissions of NO<sub>x</sub>, CO and VOM during an hour that includes a startup shall be assumed to be at the limits in Table 1A or 1B, as applicable, multiplied by a startup factor (S<sub>oil</sub>): S<sub>NOX</sub> = 1, S<sub>CO</sub> = 3 and S<sub>VOM</sub> = 1.5 when firing fuel oil. For example, the CO emissions during an hour that includes startup when firing natural gas when ambient temperature is above 59°F shall be assumed to be 203.0 lb/hr (7 x 29.0 = 203.0), unless an alternative determination of startup emissions is approved by the Illinois EPA in a subsequent permit.
3. The listed SO<sub>2</sub> annual emissions are effective before January 1, 2017. The SO<sub>2</sub> annual emissions listed in parentheses go into effect on January 1, 2017.

The establishment of these procedures for determining compliance with the annual emission limits shall not shield the Permittee from responsibility to account for all emissions from the source, including emissions during startup or upset conditions, as other credible information may demonstrate that the above procedures do not adequately account for the actual emissions of the source.

Table 1D

Annual Emissions<sup>1,2</sup> (Ton/Year) for Each CT

Pollutant	Natural Gas		Fuel Oil (Backup Fuel)	
	1,800 Hours	2,300 Hours	500 Hours	(Total) <sup>1</sup>
NO <sub>x</sub>	54.00	69.00	80.25	(134.25)
CO	26.10	33.35	16.25	( 42.35)
PM/PM <sub>10</sub>	17.10	21.85	11.00	( 28.10)
VOM	2.52	3.22	1.88	( 4.44)
SO <sub>2</sub>	3.4271	4.3774	22.55 (0.69)	( 25.97) (4.40)

1. Total emissions include 1,800 hours of each CT operation firing natural gas and 500 hours of operation on backup fuel.

2. The listed SO<sub>2</sub> annual emissions are effective before January 1, 2017. The SO<sub>2</sub> annual emissions listed in parentheses go into effect on January 1, 2017.

Table 2

Project Emissions (Ton/Yr)

Unit	NO <sub>x</sub>	CO	PM	VOM	SO <sub>2</sub> <sup>1</sup>
Turbines (CTs)	402.8	127.1	84.3	13.3	77.9 (14.2)
Fuel Heaters	5.2	6.9	4.3	0.9	0.1
Fuel Storage Tank				0.1	
Total Emissions	408.0	134.0	88.6	14.3	78.0 (14.3)

1. The listed SO<sub>2</sub> project emissions are effective before January 1, 2017. The SO<sub>2</sub> annual emissions listed in parentheses go into effect on January 1, 2017.

RPS:psj

## Appendix C

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Affidavit and Hearing Request Denial



Zion Energy Center, operated by Calpine Operating Services Company, Inc., is denying that a hearing should be held in this matter.

Heidi M. Whidden 6/13/16  
Heidi M. Whidden Date  
Director, Environmental Services East Region  
Calpine Operating Services Company, Inc.

I hereby affirm that all information contained in this submission is true and accurate to the best of my knowledge and belief.

I do hereby swear that I am a duly authorized representative of the operator and I am authorized to sign this affidavit.

**Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))**

Heidi M. Whidden 6/13/16  
Heidi M. Whidden Date  
Director, Environmental Services East Region  
Calpine Operating Services Company, Inc.

State of Delaware  
County of New Castle

Signed and sworn to before me on June 13, 2016 by Heidi M. Whidden,  
Director, Environmental Services East Region, Calpine Operating Services  
Company, Inc.



Kellyanne P. Gallagher  
Signature of Notarial Officer  
Office Manager  
Title (and Rank)

Commission Expires: Nov. 13, 2016



Turbines (CT-1, CT-2, and CT-3) Represented emissions are from 1 of the 3 identical turbines.	
<b>Assumptions:</b>	
Natural Gas Fired and Distillate Oil #2 Back-up Natural Gas Total Rated Capacity, MMBtu/hr	1,719
Fuel Consumption, MMscf/hr	1,6853
Total Hours of Operation (each)	2,300
#2 Oil Total Rated Capacity, MMBtu/hr	1,928
Fuel Consumption, gal/hr	14,073
Hours of Operation on #2 Oil (each)	500
Maximum Sulfur Content, ppmv	15
Maximum Sulfur Content, %	0.0015
<b>Conversion Factors:</b>	
lb/ton	2,000
lb/kg	2.204
CO <sub>2</sub> to CO <sub>2e</sub>	1
CH <sub>4</sub> to CO <sub>2e</sub>	25
N <sub>2</sub> O to CO <sub>2e</sub>	298
hours/yr	8,760
Btu/scf (natural gas)	1,020
Btu/gal (distillate oil #2)	137,000
Btu/MMBtu	1,000,000
gal/1000 gal	1,000

Pollutant	Natural Gas Emission Factors <sup>1,3</sup>		Unlimited Annual Emissions (TPY)	Limited Annual Emissions (TPY)
NO <sub>x</sub>				
CO				
VOM				
PM				
PM <sub>10</sub>				
PM <sub>2.5</sub>				
SO <sub>2</sub>	0.0024	lb/MMBtu	4.13	lb/hr
Lead				
CO <sub>2e</sub> <sup>3</sup>				
CO <sub>2</sub> <sup>4</sup>				
CH <sub>4</sub> <sup>5</sup>				
N <sub>2</sub> O <sup>5</sup>				

Pollutant	Fuel Oil Emission Factors <sup>1,2</sup>		Unlimited Annual Emissions (TPY)	Limited Annual Emissions (TPY)
NO <sub>x</sub>				
CO				
VOM				
PM				
PM <sub>10</sub>				
PM <sub>2.5</sub>				
SO <sub>2</sub>	0.0015	lb/MMBtu	2.92	lb/hr
Lead				
CO <sub>2e</sub> <sup>3</sup>				
CO <sub>2</sub> <sup>4</sup>				
CH <sub>4</sub> <sup>5</sup>				
N <sub>2</sub> O <sup>5</sup>				

1 Emission factors are based on unit permitted emission rates when ambient temperatures is 59°F or lower (worst-case).  
 2 Hourly emissions are based on the maximum design maximum horsepower output.  
 3 CO<sub>2e</sub> emissions are based on global warming potential of CO<sub>2</sub>=1, CH<sub>4</sub>=25, and N<sub>2</sub>O=298 from 40 CFR 98 Subpart A Table A-1, November 29, 2013.  
 4 CO<sub>2</sub> emission factor from 40 CFR 98 Subpart C Table C-1 (53.06 kg CO<sub>2</sub>/MMBtu natural gas and 73.96 kg CO<sub>2</sub>/MMBtu for distillate fuel oil no. 2), November 29, 2013.  
 5 CH<sub>4</sub> and N<sub>2</sub>O emission factors from 40 CFR 98 Subpart C, Table C-2, (CH<sub>4</sub> = 0.001 kg CH<sub>4</sub>/MMBtu and N<sub>2</sub>O = 0.0001 kg N<sub>2</sub>O/MMBtu for natural gas and CH<sub>4</sub> = 0.004 kg CH<sub>4</sub>/MMBtu and N<sub>2</sub>O = 0.0006 kg N<sub>2</sub>O/MMBtu for distillate oil no. 2), November 29, 2013.

**Turbines (CT-1, CT-2, and CT-3)**  
 Represented emissions are from 1 of the 3 identical turbines.

<b>Assumptions:</b>	
Natural Gas Fired and Distillate Oil #2 Back-up Natural Gas Total Rated Capacity, MMBtu/hr <sup>6</sup>	1,644
Fuel Consumption, MMsct/hr	1,6118
Total Hours of Operation (each)	2,300
#2 Oil Total Rated Capacity, MMBtu/hr <sup>6</sup>	1,812
Fuel Consumption, gal/hr	13,226
Hours of Operation on #2 Oil (each)	500
Maximum Sulfur Content, ppmv	15
Maximum Sulfur Content, %	0.0015
<b>Conversion Factors:</b>	
lb/ton	2,000
lb/kg	2.204
CO <sub>2</sub> to CO <sub>2</sub> e	1
CH <sub>4</sub> to CO <sub>2</sub> e	25
N <sub>2</sub> O to CO <sub>2</sub> e	298
hours/yr	8,760
Btu/scf (natural gas)	1,020
Btu/gal (distillate oil #2)	137,000
Btu/MMBtu	1,000,000
gal/1000 gal	1,000

Pollutant	Natural Gas Emission Factors <sup>1,2</sup>	Unlimited Annual Emissions (TPY)	Limited Annual Emissions (TPY)
NO <sub>x</sub>			
CO			
VOM			
PM			
PM <sub>10</sub>			
PM <sub>2.5</sub>			
SO <sub>2</sub>	0.0022 lb/MMBtu	3.62 lb/hr	15.84
Lead			
CO <sub>2</sub> e <sup>3</sup>			
CO <sub>2</sub> <sup>4</sup>			
CH <sub>4</sub> <sup>5</sup>			
N <sub>2</sub> O <sup>5</sup>			

Pollutant	Fuel Oil Emission Factors <sup>1,2</sup>	Unlimited Annual Emissions (TPY)	Limited Annual Emissions (TPY)
NO <sub>x</sub>			
CO			
VOM			
PM			
PM <sub>10</sub>			
PM <sub>2.5</sub>			
SO <sub>2</sub>	0.0015 lb/MMBtu	2.75 lb/hr	12.02
Lead			
CO <sub>2</sub> e <sup>3</sup>			
CO <sub>2</sub> <sup>4</sup>			
CH <sub>4</sub> <sup>5</sup>			
N <sub>2</sub> O <sup>5</sup>			

1 Emission factors are based on unit permitted emission rates when ambient temperatures is 59°F or greater (not worst-case).  
 2 Hourly emissions are based on the maximum design maximum horsepower output.  
 3 CO<sub>2</sub>e emissions are based on global warming potential of CO<sub>2</sub>=1, CH<sub>4</sub>=25, and N<sub>2</sub>O=298 from 40 CFR 98 Subpart A Table A-1, November 29, 2013.  
 4 CO<sub>2</sub> emission factor from 40 CFR 98 Subpart C Table C-1 (53.06 kg CO<sub>2</sub>/MMBtu natural gas and 73.96 kg CO<sub>2</sub>/MMBtu for distillate fuel oil no. 2), November 29, 2013.  
 5 CH<sub>4</sub> and N<sub>2</sub>O emission factors from 40 CFR 98 Subpart C, Table C-2, (CH<sub>4</sub> = 0.001 kg CH<sub>4</sub>/MMBtu and N<sub>2</sub>O = 0.0001 kg N<sub>2</sub>O/MMBtu for natural gas and CH<sub>4</sub> = 0.004 kg CH<sub>4</sub>/MMBtu and N<sub>2</sub>O = 0.0006 kg N<sub>2</sub>O/MMBtu for distillate oil no. 2), November 29, 2013.  
 6 The rated capacities listed are based off the vendor/manufacturer data provided in Construction Permit 99110042 and reflect the reduced power output and fuel consumption due to higher ambient temperatures. These emissions are not considered worst-case.

Project: Calpine - Zion Energy Center  
 Subject: Turbine Emission Comparisons  
 Task: Turbine PTE

Prepared: CWB  
 Reviewed: KSA  
 Date: March 2016

Turbines (GT-1, GT-2, and GT-3) Represented emissions are from 1 of the 3 identical turbines.	
Assumptions:	
Natural Gas Fired and Distillate Oil #2 Back-up	
Total Hours of Operation (each)	2,300
Hours of Operation on #2 Oil (each)	500
Conversion Factors:	
lb/ton	2,000

Pollutant	Natural Gas Emission Factors			Annual Emissions 1800 Hours of Operation (TPY)
	Less than 59°F (lb/hr)	Greater Than 59°F (lb/hr)	Worstcase (lb/hr)	
NO <sub>x</sub>				
CO				
VOM				
PM				
PM <sub>10</sub>				
PM <sub>2.5</sub>				
SO <sub>2</sub>	4.13	3.62	4.13	3.71
Lead				
CO <sub>2</sub> e				
CO <sub>2</sub>				
CH <sub>4</sub>				
N <sub>2</sub> O				

Pollutant	Fuel Oil Emission Factors			Annual Emissions 500 Hours of Operation (TPY)
	Less than 59°F (lb/hr)	Greater Than 59°F (lb/hr)	Worstcase (lb/hr)	
NO <sub>x</sub>				
CO				
VOM				
PM				
PM <sub>10</sub>				
PM <sub>2.5</sub>				
SO <sub>2</sub>	2.92		2.92	0.69
Lead				
CO <sub>2</sub> e				
CO <sub>2</sub>				
CH <sub>4</sub>				
N <sub>2</sub> O				

Pollutant	Single Turbine Annual Emissions 2300 Hours of Operation on Natural Gas (TPY)	Single Turbine Annual Emissions 1800 Hours of Operation on Natural Gas and 500 Hours of Operation on Fuel Oil (TPY)	All Turbine Annual Emissions 2300 Hours of Operation on Natural Gas (TPY)
	NO <sub>x</sub>		
CO			
VOM			
PM			
PM <sub>10</sub>			
PM <sub>2.5</sub>			
SO <sub>2</sub>	4.74	4.40	14.23
Lead			
CO <sub>2</sub> e			
CO <sub>2</sub>			
CH <sub>4</sub>			
N <sub>2</sub> O			

## Appendix E

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### Fuel Combustion and Dilution Scenarios

Zion Energy Center  
 Projected Distillate Oil Combustion Scenario  
 Readiness Testing and Projected Operation - Low Case

Event Description	Hours of Operation per Turbine	Oil in Storage Tank gallons	Sulfur Content (ppm)	parts of S	Oil in Storage Tank gallons	Calculated Sulfur Content of Oil in Storage Tank (ppm)
2016 Start	-	960,000	113	108,480,000	-	-
2016 Readiness Testing	4	168,000	113	18,984,000	-	-
2016 Added Fuel	-	168,000	15	2,520,000	960,000	95.9
2017 Start	-	960,000	95.9	92,016,000	-	-
2017 Operating Event	4	168,000	95.9	16,102,800	-	-
2017 Added Fuel	-	168,000	15	2,520,000	960,000	81.7
2017 Post Event	-	960,000	81.7	78,433,200	-	-
2017 Readiness Testing	4	168,000	81.7	13,725,810	-	-
2017 Added Fuel	-	168,000	15	2,520,000	960,000	70.0
2018 Start	-	960,000	70.0	67,227,390	-	-
2018 Operating Event	4	168,000	70.0	11,764,793	-	-
2018 Added Fuel	-	168,000	15	2,520,000	960,000	60.4
2018 Post Event	-	960,000	60.4	57,982,597	-	-
2018 Readiness Testing	4	168,000	60.4	10,146,954	-	-
2018 Added Fuel	-	168,000	15	2,520,000	960,000	52.5
2019 Start	-	960,000	52.5	50,355,642	-	-
2019 Operating Event	4	168,000	52.5	8,812,237	-	-
2019 Added Fuel	-	168,000	15	2,520,000	960,000	45.9
2019 Post Event	-	960,000	45.9	44,063,405	-	-
2019 Readiness Testing	4	168,000	45.9	7,711,096	-	-
2019 Added Fuel	-	168,000	15	2,520,000	960,000	40.5
2020 Start	-	960,000	40.5	38,872,309	-	-
2020 Operating Event	4	168,000	40.5	6,802,654	-	-
2020 Added Fuel	-	168,000	15	2,520,000	960,000	36.0
2020 Post Event	-	960,000	36.0	34,589,655	-	-
2020 Readiness Testing	4	168,000	36.0	6,053,190	-	-
2020 Added Fuel	-	168,000	15	2,520,000	960,000	32.4
2021 Start	-	960,000	32.4	31,056,465	-	-
2021 Operating Event	4	168,000	32.4	5,434,881	-	-
2021 Added Fuel	-	168,000	15	2,520,000	960,000	29.3
2021 Post Event	-	960,000	29.3	28,141,584	-	-
2021 Readiness Testing	4	168,000	29.3	4,924,777	-	-
2021 Added Fuel	-	168,000	15	2,520,000	960,000	26.8

Zion Energy Center  
 Projected Distillate Oil Combustion Scenario  
 Readiness Testing and Projected Operation - Average Case

Event Description	Hours of Operation per Turbine	Oil in Storage Tank gallons	Sulfur Content (ppm)	parts of S	Oil in Storage Tank gallons	Calculated Sulfur Content of Oil in Storage Tank (ppm)
2016 Start	-	960,000	113	108,480,000	-	-
2016 Readiness Testing	6	252,000	113	28,476,000	-	-
2016 Added Fuel	-	252,000	15	3,780,000	960,000	87.3
2017 Start	-	960,000	87.3	83,784,000	-	-
2017 Operating Event	4	168,000	87.3	14,662,200	-	-
2017 Added Fuel	-	168,000	15	2,520,000	960,000	74.6
2017 Post Event	-	960,000	74.6	71,641,800	-	-
2017 Readiness Testing	6	252,000	74.6	18,805,973	-	-
2017 Added Fuel	-	252,000	15	3,780,000	960,000	59.0
2018 Start	-	960,000	59.0	56,615,828	-	-
2018 Operating Event	4	168,000	59.0	9,907,770	-	-
2018 Added Fuel	-	168,000	15	2,520,000	960,000	51.3
2018 Post Event	-	960,000	51.3	49,228,058	-	-
2018 Readiness Testing	6	252,000	51.3	12,922,365	-	-
2018 Added Fuel	-	252,000	15	3,780,000	960,000	41.8
2019 Start	-	960,000	41.8	40,085,693	-	-
2019 Operating Event	4	168,000	41.8	7,014,996	-	-
2019 Added Fuel	-	168,000	15	2,520,000	960,000	37.1
2019 Post Event	-	960,000	37.1	35,590,696	-	-
2019 Readiness Testing	6	252,000	37.1	9,342,558	-	-
2019 Added Fuel	-	252,000	15	3,780,000	960,000	31.3
2020 Start	-	960,000	31.3	30,028,139	-	-
2020 Operating Event	4	168,000	31.3	5,254,924	-	-
2020 Added Fuel	-	168,000	15	2,520,000	960,000	28.4
2020 Post Event	-	960,000	28.4	27,293,214	-	-
2020 Readiness Testing	6	252,000	28.4	7,164,469	-	-
2020 Added Fuel	-	252,000	15	3,780,000	960,000	24.9
2021 Start	-	960,000	24.9	23,908,746	-	-
2021 Operating Event	4	168,000	24.9	4,184,030	-	-
2021 Added Fuel	-	168,000	15	2,520,000	960,000	23.2
2021 Post Event	-	960,000	23.2	22,244,715	-	-
2021 Readiness Testing	6	252,000	23.2	5,839,238	-	-
2021 Added Fuel	-	252,000	15	3,780,000	960,000	21.0



Zion Energy Center  
 Projected Distillate Oil Combustion Scenario  
 Readiness Testing and Projected Operation - High Case

Event Description	Hours of Operation per Turbine	Oil in Storage Tank gallons	Sulfur Content (ppm)	parts of S	Oil in Storage Tank gallons	Calculated Sulfur Content of Oil in Storage Tank (ppm)
2016 Start	-	960,000	113	108,480,000	-	-
2016 Readiness Testing	8	336,000	113	37,968,000	-	-
2016 Added Fuel	-	336,000	15	5,040,000	960,000	78.7
2017 Start	-	960,000	78.7	75,552,000	-	-
2017 Operating Event	4	168,000	78.7	13,221,600	-	-
2017 Added Fuel	-	168,000	15	2,520,000	960,000	67.6
2017 Post Event	-	960,000	67.6	64,850,400	-	-
2017 Readiness Testing	8	336,000	67.6	22,697,640	-	-
2017 Added Fuel	-	336,000	15	5,040,000	960,000	49.2
2018 Start	-	960,000	49.2	47,192,760	-	-
2018 Operating Event	4	168,000	49.2	8,258,733	-	-
2018 Added Fuel	-	168,000	15	2,520,000	960,000	43.2
2018 Post Event	-	960,000	43.2	41,454,027	-	-
2018 Readiness Testing	8	336,000	43.2	14,508,909	-	-
2018 Added Fuel	-	336,000	15	5,040,000	960,000	33.3
2019 Start	-	960,000	33.3	31,985,118	-	-
2019 Operating Event	4	168,000	33.3	5,597,396	-	-
2019 Added Fuel	-	168,000	15	2,520,000	960,000	30.1
2019 Post Event	-	960,000	30.1	28,907,722	-	-
2019 Readiness Testing	8	336,000	30.1	10,117,703	-	-
2019 Added Fuel	-	336,000	15	5,040,000	960,000	24.8
2020 Start	-	960,000	24.8	23,830,019	-	-
2020 Operating Event	4	168,000	24.8	4,170,253	-	-
2020 Added Fuel	-	168,000	15	2,520,000	960,000	23.1
2020 Post Event	-	960,000	23.1	22,179,766	-	-
2020 Readiness Testing	8	336,000	23.1	7,762,918	-	-
2020 Added Fuel	-	336,000	15	5,040,000	960,000	20.3
2021 Start	-	960,000	20.3	19,456,848	-	-
2021 Operating Event	4	168,000	20.3	3,404,948	-	-
2021 Added Fuel	-	168,000	15	2,520,000	960,000	19.3
2021 Post Event	-	960,000	19.3	18,571,899	-	-
2021 Readiness Testing	8	336,000	19.3	6,500,165	-	-
2021 Added Fuel	-	336,000	15	5,040,000	960,000	17.8



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