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USE OF CUSTOMER-OWNED DIESEL-FUELED GENERATION IN DEMAND RESPONSE PROGRAMS

ENVIRONMENTAL ASSESSMENT

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CHAPTER 1 - PURPOSE AND NEED

Several participants in TVA demand response programs own and operate diesel-fueled generators for backup power during demand response events, when the program participants are required to reduce their use of TVA-supplied electricity by a pre-determined amount. Due to limits that TVA imposed on the use of diesel-fueled generators several years ago because of air quality concerns, the ability of demand response program participants to use backup diesel-fueled generators will soon end. The U.S. Environmental Protection Agency (USEPA) has also recently imposed more stringent standards for the emission of air pollutants by the types of diesel generators used during demand response events. TVA has received several requests from current and potential demand response program participants to review and approve the use of diesel-fueled generators meeting current emission regulations during demand response events.

1.1 TVA Policy on Diesel-Fueled Generation

In 2001, TVA established a policy that it would not pursue or consider new contracts for the use of diesel-fueled generators to generate electricity to meet its power supply needs. This policy was based on the environmental and operational characteristics of diesel-fueled generation. On a per megawatt (MW) basis, diesel generators lacking advanced nitrogen oxide (NO_X) emission reduction systems emitted significantly more NO_X than natural gas-fueled combustion turbines, the generation source most likely to be replaced by diesel-fueled generation. Diesel generators also lacked operational flexibility and required significant administrative oversight relative to their potential generating capacity.

In 2011, the TVA Board of Directors authorized the development and implementation of demand response products with conditions that included meeting applicable environmental requirements and prohibiting participants from using diesel-fueled generation to meet load requirements during demand response events. In July 2015, the TVA Board of Directors revised their 2011 authorization for demand response products to allow the future use of diesel-fueled generation following completion of the necessary environmental reviews and approval by the TVA Chief Executive Officer.

In 2013, the USEPA issued regulations establishing new emission standards for stationary internal combustion engines, including the diesel-fueled generators used by TVA demand response program participants (USEPA 2013). These regulations included a provision establishing less stringent emission requirements for generators used for emergency demand response. This provision was subsequently challenged in the United States Court of Appeals for the D.C. Circuit and vacated in a May 2015 court ruling effective on May 1, 2016. Pursuant to this ruling, diesel-fueled generators with the less stringent emergency-use permits are no longer allowed in demand response programs after May 1, 2016 (USEPA 2016a). These generators would be required to meet USEPA’s compression ignition engine / reciprocating internal combustion engine emission standards for non-emergency operation and would have to obtain the associated emissions permit issued under the Clean Air Act.

1.2 TVA Demand Response Programs

Like many other utilities, TVA includes demand response programs in its energy resource portfolio. Demand response programs focus on reducing electricity use at peak demand times across the TVA power system. By reducing peak demand, the need for utilities to increase generation resources to meet peak demand levels is reduced and the impacts and costs of acquiring or constructing and operating such resources are avoided.

Through agreements between TVA and end use customers, TVA can curtail the availability of power to these customers in the event of power system emergencies or for economic or reliability reasons. In 2014-2015, TVA reliability-based demand response programs (i.e., for power system emergencies) had about 600 MW of peak reduction capacity and programs for reliability and economic reasons had about 560 MW of peak reduction capacity (TVA 2015a). In its 2015 Integrated Resource Plan (IRP), TVA decided to increase the capacity of its demand response programs by between 450 and 575 MW by 2033, dependent on availability and cost (TVA 2015a). The resulting increase in demand response capacity over the current capacity of 1,160 MW would be between 39 and 50 percent by 2033 and the total demand response program capacities would be between 1,610 and 1,735 MW by 2033.

TVA has two types of demand response programs: reliability-based programs and reliability- and economic-based programs.

Reliability-based programs are operated to maintain the reliability of the TVA power system during times of high demand or other contingencies when a reduction in electrical load is necessary to otherwise maintain electrical service. In December 2007, TVA established the 5 Minute Response (5 MR) and the 60 Minute Response (60 MR) reliability-based demand response programs. Participants in these programs receive credits on their power bills in exchange for reducing their electrical load to a previously determined level during critical times within either 5 minutes or 60 minutes of advance notice. In 2015, there were 72 participants in the 5 MR program with an average combined on-peak interruptible load of 513 MW and 12 participants in the 60 MR program with an average combined on-peak interruptible load of 36 MW (TVA 2015b). Because these programs were established solely for power system reliability purposes, TVA did not limit the use of diesel generation by participants during demand response events.

Reliability- and economic-based programs are operated for a combination of reliability and economic (i.e., when TVA would have to purchase power at an uneconomic market price or generate its own power at an uneconomic cost) purposes. In 2011, TVA established the Reserve Preservation (RP) reliability- and economic-based demand response program. Participants in this program receive credits for reducing their electrical load within 30 minutes of notification of events. Because of its economic-based component, participants in the RP program are not allowed to use diesel generation during demand response events. In 2015 there were 16 participants in RP program with an average combined on-peak interruptible load of 620 MW (TVA 2015b).

In 2015, TVA introduced the new Interruptible Power (IP) demand response program to replace the 5 MR, 60 MR, RP, and other demand response programs (TVA 2015b). Interruptible Power participants have two options: a 5-minute reliability-based product (IP5) and a 30-minute reliability- and economic-based product (IP30). Participants in the 5 MR and 60 MR programs that transition to IP5 were allowed to continue to use their backup diesel generators during demand response events for the remaining terms of their MR demand response contracts.

TVA currently has 16 participants in the 5 MR, 60 MR, and IP5 programs with the ability to use diesel generators to meet their load during reliability-based demand response events. These 16 participants have a total diesel-fueled generating capacity of 56 MWs. Fourteen of the 16 participants are located in Tennessee and the others are in Kentucky and Mississippi. Their facilities are in both urban areas, such as Knoxville and Nashville, and rural areas. The diesel generators owned by these participants range in capacity from approximately 0.40 MW to 5 MW in capacity, and several participants own multiple generators with combined capacity of up to 10 MW. This diesel capacity comprises approximately 9 percent of the 638-MW total capacity of the three reliability-based demand response programs (5 MR, 60 MR, and IP5) as of September, 2016. Current (September 2016) participants in the reliability- and economic-based RP and IP30 programs have 445 MWs of average on-peak interruptible capacity and are not at present allowed to utilize backup diesel generators during demand response events. TVA expects a total capacity of 1,120 MW for the combined reliability-based and reliability-and economic- based programs at the end of fiscal year 2016. About 5 percent of this total demand response capacity can be met by customer-owned diesel generation.

It is important to note that few, if any, of the demand response participants with the ability to use diesel generators during demand response events installed diesel generators solely for the purposes of using them during demand response events. These generators have typically been installed to provide emergency backup power during outages and for other purposes.

From fiscal year 2007 through 2015, demand response events under the reliability-based 5 MR and 60 MR programs interrupted the delivery of a total of 14,399 megawatt-hours (MWh) of electrical load. About 99 percent of this, 14,211 MWh, was in 2014 during a period of extreme cold; the remainder was in 2012. The maximum number of event notifications to any participant during either of these years was 2 and the maximum hours per year of load reduction for any participant was 20. Assuming that all 56 MW of participant-owned diesel generating capacity was available during the 2014 events and all eligible participants operated their diesel generators during these events to offset their load reduction, the diesel generators would have generated about 1,111 MWh of electricity during these events, representing about 8 percent of the total MWh of load reduction.

Reliability- and economic-based RP demand response events occurred annually from 2011 to 2015 and interrupted a total electrical load of 27,319 MWh. The annual average load interruption was 5,464 MWh and annual amounts ranged from 2,226 MWh in 2011 to 10,347 MWh in 2012. The maximum number of annual event notifications to any RP participant was 5 and the maximum number of hours per year of load reduction was 20. The maximum annual amount of combined reliability-based and reliability- and economic-based load interruptions was 20,485 MWh in 2014.

1.3 Proposed Action

In response to the recent changes in emission standards for diesel-fueled generators used during demand response events and the continued interest in their use by demand response participants, TVA proposes to authorize the use of customer-owned diesel-fueled generators with the appropriate non-emergency use permit to provide backup generation during reliability-based 5 MR, 60 MR, and IP5 demand response events. TVA also proposes to allow participants in the reliability- and economic-based IP30 and RP programs to utilize customer-owned diesel-fueled generators with the appropriate emissions permit during demand response events.

CHAPTER 2 - ALTERNATIVES

This chapter describes the No Action Alternative and the Proposed Action Alternative.

2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to allow the operation of existing diesel-fueled generators meeting applicable emission requirements by 5 MR, 60 MR, and IP5 program participants to meet load requirements during demand response events for the remainder of their current contracts. Based on information about these generators available to TVA, at least 12 of the diesel generators operated during demand response events, with a combined capacity of 32 MW, do not meet the new emission standards for non-emergency operation. These generators, unless modified to meet the new standards, could not be operated during demand response events. In accordance with the existing TVA Board directive, TVA would prohibit the use of diesel generators by new participants in its demand response programs.

2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would allow participants in the reliability-based 5 MR, 60 MR, and IP5 programs and the reliability- and economic-based IP30 and RP programs to use customer-owned diesel generators meeting current and any future applicable emission standards to provide generation during demand response events.

At least four of the current participants in the reliability-based programs have indicated that their diesel generators, with a combined capacity of 24 MW, meet the current more stringent emission standards. Some of the reliability-based program participants with generators that do not meet the current standards may upgrade their generators or install new generators that meet the standards. The number likely to do this is not known at this time.

Because the incentives for customers participating in the reliability- and economic-based IP30 and RP programs are only slightly higher than those for participants in the reliability-only programs, participants in the IP30 and RP programs who do not already own diesel generators for other purposes are not expected to install such generators to provide backup power during demand response events. Some current and future participants in these programs could install diesel generators for other purposes and would be eligible to use these generators during demand response events.

Given the uncertainty in the number of future participants in the two types of demand response programs that are likely to operate diesel generators during demand response events, TVA has made the following assumptions:

1) The total diesel generating capacity in the next few years (“near-tern”) will not exceed the 56-MW capacity of recent reliability-based program participants.

2) Total annual near-term diesel generation will not exceed 1,111 MWh, the maximum annual amount during the years 2007-2015.

3) The proportion of demand response participants will remain at the recent five percent as the capacity of the demand response increases to its currently planned capacity of between 1,610 and 1,735 MW by 2033. At the maximum program increase to 1,735 MW, diesel generation is assumed to provide 87 MW of capacity.

4) The maximum annual demand response interruptions will increase at the same rate as overall demand response capacity growth, with a future maximum annual load interruption of 30,728 MWh. Five percent of this, 1,536 MWh, is assumed to be met by diesel generation.

CHAPTER 3 – EXISTING ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

The existing participants in the reliability-based demand response programs with diesel generators include manufacturing facilities, universities, hospitals, municipal water plants, and a large hotel/entertainment complex. Their generators are on developed industrial and institutional campuses in rural and urban settings. The installation and operation of these generators are subject to several environmental regulations in addition to the previously described air quality regulations; these regulations address topics such as the containment of spilled fuel and, depending on the locale, noise. Any replacements or upgrades of existing generators, changes in their operations, or the unlikely installation of new generators resulting from the proposed action are unlikely to affect biological resources including endangered and threatened species and wetlands, water resources, geology and soils, land use, floodplains, visual resources, historic properties, transportation, and recreation. The proposed action would have a very small beneficial effect on socioeconomics through slightly lowering the cost of generating electricity at peak demand times. Some of the current and future demand response participants with diesel generators are or likely would be located in areas with high proportions of minority and/or low-income residents. Based on the environmental consequences described below, the operation of diesel-fueled generators during demand-response events is unlikely to result in disproportionately adverse effects to minority or low income residents, and the Proposed Action Alternative would not have disproportionate impacts on minority and/or low income populations. Environmental resources that could be affected by the proposed action are air quality, climate change and greenhouse gas emissions, and noise. These resources are addressed in more detail below.

3.1 Air Quality

Affected Environment – Through its passage of the Clean Air Act (CAA), Congress has mandated the protection and enhancement of our nation's air quality resources. National Ambient Air Quality Standards (NAAQS; USEPA 2015a) for the following criteria pollutants have been set to protect the public health and welfare:

- sulfur dioxide (SO_2),
- ozone (O_3),
- nitrogen dioxide (NO_2),
- particulate matter whose particles are ≤ 10 micrometers (PM_{10}),
- particulate matter whose particles are ≤ 2.5 micrometers ($PM_{2.5}$),
- carbon monoxide (CO), and
- lead (Pb).

The primary NAAQS were promulgated to protect the public health, and the secondary NAAQS were promulgated to protect the public welfare from any known or anticipated adverse effects associated with the presence of pollutants in the ambient air (e.g., visibility, crops, forests, soils and materials). A listing of the NAAQS is presented in Table 3-1.

Ambient air monitors measure concentrations of these pollutants to determine attainment with these standards. Areas in violation of the NAAQS are designated as nonattainment areas and must develop plans to improve air quality and achieve the

NAAQS. New sources of air pollution in or near these areas may be subject to more stringent air permitting requirements.

Air quality in the TVA power service area is generally very good. The entire TVA region is currently in attainment with the NAAQS for carbon monoxide, nitrogen oxides, PM_{10} particulate matter, and lead (USEPA 2016b).

All areas of the region are currently also in attainment with the ozone NAAQS (USEPA 2016b). Several counties in the vicinity of Knoxville and Memphis, including Shelby, Knox, Blount, and part of Anderson Counties, had previously been designated as nonattainment for ozone. In 2015 and 2016 they were redesignated as in attainment subject to maintenance plans to prevent “backsliding” (USEPA 2015b, 2016c).

Table 3.1. National Ambient Air Quality Standards

Pollutant	Primary / Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 μg/m^3 [1]	Not to be exceeded
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	Annual	53 ppb [2]	Annual Mean
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm [3]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particulate Matter ($PM_{2.5}$)	primary	Annual	12.0 μg/m^3	annual mean, averaged over 3 years
	secondary	Annual	15.0 μg/m^3	annual mean, averaged over 3 years
	primary and secondary	24-hours	35 μg/m^3	98th percentile, averaged over 3 years
Particulate Matter (PM_{10})	primary and secondary	24-hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	primary	1-hour	75 ppb [4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3-hours	0.5 ppm	Not to be exceeded more than once per year

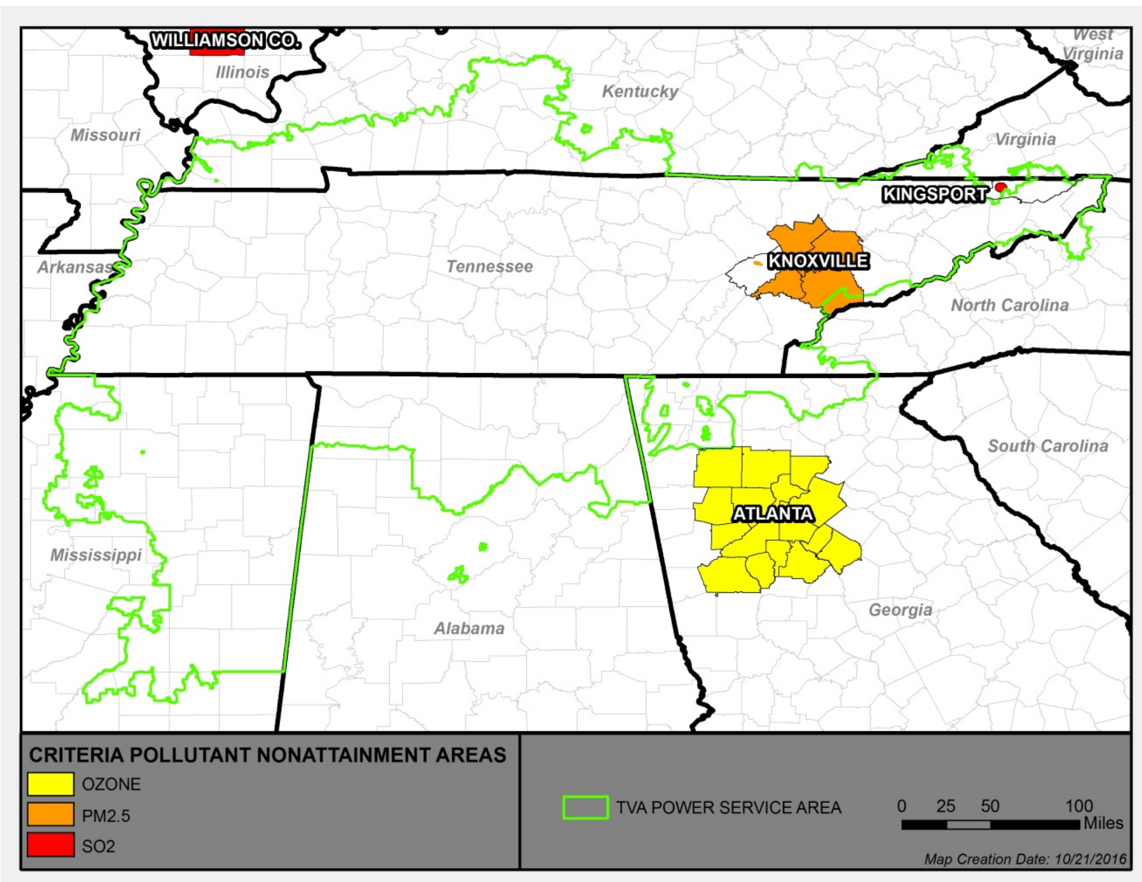
Source: USEPA (2015a)
Notes:
1 In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 μg/m^3 as a calendar quarter average) also remain in effect.
2 The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

3 Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

4 The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards (40 CFR 50.4(3)), A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the require NAAQS.

The majority of the region is in attainment for the $PM_{2.5}$ NAAQS; however, five counties in the vicinity of Knoxville are designated non-attainment for both the annual $PM_{2.5}$ NAAQS and the 24-hour $PM_{2.5}$ NAAQS. These counties are Anderson, Blount, Knox, Loudon, and part of Roane County (Figure 3.1. Monitoring data shows that this area is now meeting these NAAQS (USEPA 2012) and it is expected to be redesignated as attainment in 2017.

Figure 3.1. TVA Service Area Nonattainment Areas of NAAQS Pollutants



The vast majority of the region is in attainment with the SO_2 NAAQS (USEPA 2012), although there is one small area in Sullivan County in northeast Tennessee which is designated as nonattainment with the 1-hour SO_2 NAAQS (Figure 3.1). This area is impacted by SO_2 emissions from a single local source and is not reflective of air quality beyond the immediate vicinity of this source. This area was designated based on monitoring data for 2009–2011. Another round of designations based on dispersion modeling will occur by December 2017; no additional areas within the TVA region are expected to be designated as nonattainment for SO_2.

Ambient air concentrations measured in the TVA region during the three year period from 2013 to 2015 are shown in Table 3.2. With the exception of a small portion of Kingsport in Sullivan County, Tennessee, ambient air concentrations in the TVA region are below the level of the NAAQS, indicating air quality is good.

Table 3.2. 2013–2015 Ambient Concentrations of Criteria Air Pollutants

Monitor Location	**CO 1-hr 2nd Max** (ppm)	**CO 8hr 2nd Max** (ppm)	**Lead Max 3-mo Avg** ($\mu g/m^3$)	**NO_2 Ann. Mean** (ppb)	**NO_2 1-hr 98th %-ile** (ppb)	**O_3 8-hr 4th Max** (ppm)	**SO_2 1-hr 99th %-ile** (ppb)	**$PM_{2.5}$ 24-hr 98th %-ile** ($\mu g/m^3$)	**$PM_{2.5}$ Ann. Mean** ($\mu g/m^3$)	**PM_{10} 24-hr 2nd Max** ($\mu g/m^3$)
		Maximum						**3-Year Average**		
NAAQS	**35**	**9**	**0.15**	**53**	**100**	**0.070**	**75**	**35**	**12**	**150**
Tennessee										
Athens							28	17	9	
Chattanooga						0.066		21	10	22
Clarksville				4	19	0.064	30	22	10	28
Cleveland							25			
Cookeville								18	8	
Dyersburg								17	9	
Jackson								18	8	
Kingsport/ Bristol	2.8	1	0.05	11	47	0.065	212	15	8	
Knoxville	1.1	0.3	0.11			0.067	6	21	11	84
Lawrence-burg								16	8	
Memphis	4.4	2	0	12	41	0.067	9	22	10	48
Morristown						0.067				
Nashville/ Davidson/ Murfreesboro / Franklin	1.7	1.4		15	48	0.069	10	21	10	37
Sevierville						0.067				
Alabama										
Decatur						0.062		18	9	
Florence / Muscle Shoals						0.058		18	9	
Fort Payne						0.063		19	9	
Huntsville						0.064		19	9	50
Mississippi										
Tupelo						0.059				
Kentucky										
Paducah				6	36	0.064	18	23	10	35

Source: USEPA 2016b.

Environmental Consequences

No Action Alternative: Under this alternative, the participants in reliability-based demand response programs with diesel-fueled generators that meet the new EPA standards would continue to operate their generators during demand response events until their current demand response contracts with TVA expire. The emissions from these generators comprise a very small proportion of emissions in the TVA power service area and the resulting emission reductions would have a negligible effect on air quality in the TVA power service area. Once the existing demand response contracts expire, the emission of air pollutants from diesel-fueled generator sets operated during demand response events, and the environmental impacts of those emissions, would cease.

Proposed Action Alternative: All participants in TVA's demand response programs will meet the stringent requirements provided in USEPA's Standards of Performance for (new) Stationary Compression Ignition Engines (USEPA 2015c) and / or National Emission Standards for Hazardous Air Pollutants for Stationary Internal Combustion Engines (USEPA 2014). For example, assuming a participant adds a new 2-MW (i.e., approximately 2,700 horsepower) diesel-fueled generator set[1], the applicable Tier 4 emission standards are provided in the following table.

Table 3.3. Tier 4 Emission Standards for Generator Sets >560 kW (750 horsepower) [1]

Pollutant	g/kW-hr [2]
Carbon Monoxide (CO)	3.5
Non-Methane Hydrocarbons (NMHC) [3]	0.19
Nitrogen Oxides (NO_X)	0.67
Particulate Matter (PM)	0.03

Notes:
1 40 CFR Part 1039 Subpart B Subsection 1039.101, Table 1.
2 *g/kW-hr* denotes grams of pollutant emitted per kilowatt-hour of engine power.
3 TVA assumes the NMHC emissions standard is equivalent to volatile organic compound (VOC) emissions.

Additionally, new or reconstructed diesel engine generators greater than 500 horsepower located at major sources of hazardous air pollutants (HAPs) must meet the following National Emission Standards for Hazardous Air Pollutants (NESHAP) standards (USEPA 2014).

- Reduce CO emissions by 70 percent or more; or
- Limit exhaust concentration of formaldehyde (CASN: 50-00-0) to 580 parts per billion, volume-dry (ppbvd) at 15 percent stack-oxygen (O_2). [Concentration equates to approximately 0.00137 pounds per million Btu.]

[1] The size of the diesel generator set selected for this example is typical of generator sets used by some current program participants and within the size range of generator sets likely to be used by future program participants. Most of the generator sets used by current participants are >560 kW. The standards for generators between 130 kW and 560 kW are the same except for NOx, which is 0.40 g/KW-hr, and PM, which is 0.02 g/kW-hr.

For purposes of this analysis, TVA assumes that approximately 28 2-MW diesel generators would be used to meet the projected near-term 56 MW of customer-owned diesel-fueled generation by the reliability-based and reliability- and economic-based program participants. The emissions associated with operating these generator sets during demand response events in accordance with the new standards are provided in Table 3.4. The actual emissions would likely differ somewhat from these estimates as emission rates vary slightly among different models of generator sets. All of the generator sets would have to meet the standards listed in Table 3.3 or the related standards for smaller generator sets. Because the emission limits for generator sets less than 560 kW are somewhat lower, the results of this analysis based on larger generator sets is conservative. Emissions of SO_2 are not considered in this evaluation because SO_2 emissions are driven by diesel fuel-sulfur content, which has been standardized to 15 parts per million since June 2010. Therefore SO_2 emissions from new diesel-fueled generator sets would be similar to those of existing generator sets.

Table 3.4. Near-Term Emission Estimates for 2-MW Diesel-Fueled Generator Sets Assumed to Generate a Total of 1,111 MWh Annually During Demand Response Events

Pollutant	Hourly	Annual	
	lb/eng-hr [1]	tons/eng-yr [2]	tons/yr [3]
Carbon Monoxide (CO)	20.0	0.200	5.60
Volatile Organic Compounds (VOC) [4]	1.08	0.0108	0.301
Nitrogen Oxides (NO_X)	3.84	0.0384	1.08
Total Particulate Matter (TPM)	0.169	< 0.01	0.0473
TPM ≤ 10 microns (TPM_{10})	0.138	< 0.01	0.0387
TPM ≤ 2.5 microns ($TPM_{2.5}$)	0.134	< 0.01	0.0374
Formaldehyde [5]	0.0335	< 0.01	< 0.01

Notes:

1 *lb/eng-hr* denotes pounds of pollutant emitted per engine per hour.
2 *tons/eng-yr* denotes tons of pollutant emitted per engine per year.
3 *tons/yr* denotes tons of pollutant emitted by 28 2- MW diesel-engine generators per year
4 TVA assumes the NMHC emission standard provided in Table 3.3 is equivalent to VOC emissions.
5 Formaldehyde emission standards are only applicable to major sources of HAPs. It is provided here for study purposes; however, it may not be relevant to all new diesel-engine generators.

With the projected near-term demand-response diesel generation capacity of 56 MW, new or modified diesel-fueled generator sets would produce less emissions compared to historical diesel-engine generators due to the more stringent diesel-engine emission standards.

Over the longer term, TVA proposes to increase the demand response program capacity by up to 50 percent, and, as described in Section 2.2, assumes 87 MWs of participant-owned diesel-fueled generating capacity would provide up to 1,536 MWh of diesel-fueled generation annually. Table 3.5 lists the estimated annual emissions from the generation of 1,536 MWh of electricity by 44 2-MW diesel-fueled generators.

Table 3.5. Emission Estimates for 2-MW Diesel-Fueled Generator Sets Assumed to Generate a Total of 1,536 MWh Annually during Demand Response Events at Maximum Program Expansion

Pollutant	Hourly	Annual	
	lb/eng-hr [1]	tons/eng-yr [2]	tons/yr [3]
Carbon Monoxide (CO)	20.0	0.200	8.40
Volatile Organic Compounds (VOC) [4]	1.08	0.0108	0.452
Nitrogen Oxides (NO_X)	3.84	0.0384	1.62
Total Particulate Matter (TPM)	0.169	< 0.01	0.0710
TPM ≤ 10 microns (TPM_{10})	0.138	< 0.01	0.0581
TPM ≤ 2.5 microns ($TPM_{2.5}$)	1.134	< 0.01	0.0561
Formaldehyde [5]	0.00335	< 0.01	0.0131

Notes:
1 *lb/eng-hr* denotes pounds of pollutant emitted per engine per hour.
2 *tons/eng-yr* denotes tons of pollutant emitted per engine per year.
3 *tons/yr* denotes tons of pollutant emitted by 44 2-MW diesel-engine generators per year during demand response events
4 TVA assumes the NMHC emission standard provided in Table 3.3 is equivalent to VOC emissions.
5 Formaldehyde emission standards are only applicable to major sources of HAPs. It is provided here for study purposes; however, it may not be relevant to all new diesel-engine generators.

While near-term emissions under the Proposed Alternative would be less than recent emissions under the existing demand response programs, there would be a slight increase in emissions compared to the No Action Alternative. Projected annual emissions from the Proposed Alternative were compared with total man-made emissions in Tennessee[2] in 2014 showing that these emissions would be very small, ranging from 0.02 to 0.46 percent of total existing emissions for the near-term assuming a maximum of 1,111 MWh of annual diesel-fueled generation during demand response events (Table 3.6). At the currently planned maximum program expansion with 1,536 MWh of annual diesel-fueled generation during demand response events, emissions would range from 0.03 to 0.69 percent of total existing emissions (Table 3.7).

Since ambient concentrations of CO, NO_2 and PM_{10} in the region are well below the level of the NAAQS (Table 3.2), an increase in emissions of this magnitude is not expected to have an adverse impact on air quality in the region.

However, ambient annual concentrations of ozone and $PM_{2.5}$ are only slightly less than the NAAQS in many areas of the region (Table 3.2). Therefore, there is less margin for emission growth without potentially causing adverse impacts. Because ozone and $PM_{2.5}$ are secondary pollutants, formed by the chemical interaction of precursor pollutants, Modeled Emissions Rates for Precursors (MERPs) were used to assess the potential impact of increased NOx and VOC emissions on ozone and $PM_{2.5}$.

[2] Emissions in Tennessee are used as the basis of this comparison because of the ready availability of state-specific emissions data. Some of the program participants operating diesel-fueled generator sets are located in other TVA region states and a comparison with emissions from the whole TVA region would show smaller proportions of region-wide emissions attributable to program participants.

Table 3.6. Comparison of Estimated Annual Emissions from Near-Term Diesel-Fueled Generators during Demand Response Events to Total Tennessee Emissions in 2014[1]

Pollutant	Total Emissions in Tennessee in 2014[1] (tons/yr)	Projected Emissions from Diesel Generators (tons/yr)[2]	Percent of Total Emissions
CO	1,222	5.60	0.46%
VOC	279	0.301	0.11%
NO_X	277	1.08	0.39%
TPM_{10}	194	0.0387	0.02%
$TPM_{2.5}$	74	0.0374	0.05%

Notes:
1 Source: EPA 2014 National Emissions Inventory (NEI) Updated March 23, 2016. https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.
2 *tons/yr* denotes tons of pollutant emitted by 28 2-MW diesel-engine generators per year.

Table 3.7. Comparison of Estimated Annual Emissions from Diesel-Fueled Generators at Maximum Program Expansion during Demand Response Events to Total Tennessee Emissions in 2014[1]

Pollutant	Total Emissions in Tennessee in 2014[1] (tons/yr)	Projected Emissions from Diesel Generators (tons/yr)[2]	Percent of Total Emissions
CO	1,222	8.40	0.69%
VOC	279	0.452	0.16%
NO_X	277	1.08	0.39%
TPM_{10}	194	0.0581	0.03%
$TPM_{2.5}$	74	0.0561	0.08%

Notes:
1 Source: EPA 2014 National Emissions Inventory (NEI) Updated March 23, 2016. https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.
2 *tons/yr* denotes tons of pollutant emitted by 44 2-MW diesel-engine generators per year.

On December 2, 2016, EPA released draft guidance for developing MERPs for ozone and $PM_{2.5}$. MERPs reflect levels of increased precursor emissions that are not expected to cause a significant contribution to ozone or $PM_{2.5}$. They can be used to demonstrate that precursor emissions from a proposed source would not have an adverse impact on air quality. Separate MERPs are used for specific precursors and their secondary pollutant impacts: SO_2 to $PM_{2.5}$, NO_X to $PM_{2.5}$, NO_X to ozone, and VOC to ozone. When a source emits multiple precursors, emissions of each precursor should be expressed as a percentage of the MERP, then summed for all precursors. A value less than 100% indicates the combined emissions would not impact air quality.

EPA had initially intended to propose a National MERP for each precursor for the issuance of Prevention of Significant Deterioration (PSD) permits (required under the CAA for new major sources of air pollutants in NAAQS attainment areas) but instead proposed guidance to develop site-specific MERPs. The guidance document does not endorse a specific MERP value, though it does provide the lowest, most conservative, illustrative MERPs from EPA's analysis of hypothetical sources in the eastern United

States (USEPA 2016e). These values were used as a screening tool to determine if the anticipated emission increases from the increased use of diesel generation during demand response events would be expected to cause a significant impact on ozone and $PM_{2.5}$ levels in the region.

Anticipated emission increases from diesel-fueled generators for the maximum program expansion (1,536 MWh of annual diesel-fueled generation) are 0.22% of the most conservative MERPs for 8-hr ozone for the eastern U.S. (Table 3.8), indicating that they would have a negligible impact on ozone levels in the region.

Table 3.8. Comparison of Estimated Emissions from Diesel-Fueled Generators at Maximum Program Expansion during Demand Response Events to Most Conservative MERP Values for Ozone Precursors[1]

Pollutant	Projected Emissions from Diesel Generators (tons/yr)[2]	Most Conservative MERP Value for 8-hr Ozone (tons/yr)	Comparison to MERP Value (%)
NO_X	1.620	107	1.51%
VOC	0.452	814	0.06%
Combined Emissions	2.072	921	0.22%

Notes:
1 Source: USEPA 2016e.
2 *tons/yr* denotes tons of pollutant emitted by 44 2-MW diesel-engine generators per year.

Anticipated emission increases from diesel-fueled generators for the maximum program expansion are 0.05% of the most conservative MERPs for 24-hr $PM_{2.5}$ for the eastern U.S. (Table 3.9), indicating that they would have a negligible impact on $PM_{2.5}$ levels in the region.

Table 3.9. Comparison of Estimated Emissions from Diesel-Fueled Generators at Maximum Program Expansion during Demand Response Events to Most Conservative MERP Values for $PM_{2.5}$ Precursors[1]

Pollutant	Projected Emissions from Diesel Generators (tons/yr)[2]	Most Conservative MERP Value for 24-hr $PM_{2.5}$ (tons/yr)	Comparison to MERP Value (%)
Primary PM	0.0561	NA[3]	NA[3]
NO_x	1.620	2,467	0.07%
SO_2	no increase	675	0.00%
Combined Emissions	1.676	3,142	0.05%

Notes:
1 Source: USEPA 2016e.
2 *tons/yr* denotes tons of pollutant emitted by 44 2-MW diesel-engine generators per year.
3 While there is no MERP for Primary PM, emissions of primary PM need to be added to the combined precursor emissions before the comparison to the MERP.

Based on these analyses, the emissions of air pollutants under the Proposed Action Alternative for both the near-term and at the maximum currently planned program expansion are not expected to have an adverse impact on air quality.

3.2 Climate Change and Greenhouse Gases

Affected Environment

"Climate change" refers to any substantive long-term change in measures of climate, such as temperature, precipitation, or wind. The 2014 National Climate Assessment (Melillo et al. 2014) concluded that global climate is projected to continue to change over this century and beyond. The amount of warming projected beyond the next few decades, by these studies, is directly linked to the cumulative global emissions of greenhouse gasses (GHGs) and particles. The assessment concluded that by the end of this century, a 3° Fahrenheit (F) to 5°F rise can be projected under the lower emissions scenario and a 5°F to 10°F rise for a higher emissions scenario (Melillo et al. 2014). As with all future scenario modeling exercises, there is an important distinction to be made between a prediction of what will happen and a projection of what future conditions are likely given a particular set of assumptions (Melillo et al. 2014).

Most of North America has exhibited an overall warming trend in surface temperature over the 20^{th} century; this trend has been much less pronounced in the southeastern United States, including the TVA service area (Kunkel et al. 2013). Historically, temperatures increased rapidly in the Southeast during the early part of the 20^{th} century, then decreased rapidly during the middle of the 20^{th} century. Since the 1960s, temperatures in the Southeast have been increasing. Recent increases in temperature in the southeast have been most pronounced in the summer season, particularly along the Gulf and Atlantic coasts. While temperature trends in the Southeast have not been statistically significant in any season, the number of very warm summer nights has tended to increase and the number of extreme cold days has tended to decrease.

Based on climate models, temperatures in the Southeast are predicted to increase during this century, with greater increase in interior Southeast areas than coastal areas. Regional average increases are in the range of 4°F to 8°F under two commonly used emissions scenarios (Carter et al. 2014, Kunkel et al. 2013). The number of days over 95°F is also projected to increase. See TVA (2015a) for a more detailed discussion of historic and projected climate trends.

GHGs absorb heat that is radiated from the surface of the earth. The primary GHG emitted by electric utilities is carbon dioxide (CO_2) produced by the combustion of coal, natural gas, and other fossil fuels. The electric utility industry is a large emitter of CO_2 and electric utilities in the U.S. emitted an estimated 2.072 billion metric tons of CO_2, roughly 37 percent of the U.S. total in 2014 (USEPA 2016d). CO_2 emissions from the generation of power marketed by TVA were 79.5 million tons in 2015, about 4 percent of annual; U.S. electric utility emissions. TVA CO_2 emissions have decreased significantly over the last two decades and are projected to continue to decrease as coal plants are retired and replaced with lower emitting generating facilities (TVA 2015a). The CO_2 emissions rate from the generation of electricity delivered to TVA customers was 1,005 lbs/MWh in 2015; as with total CO_2 emissions, the CO2 emissions rate has decreased significantly and is projected to continue to decrease (TVA 2015a).

Diesel-fueled generator sets of the type operated by demand response program participants have a CO_2 emission rate of about 1,640 lbs/MWh (USEIA 2016). Small quantities of emissions of other GHGs (methane and nitrous oxide) would result in a slightly higher overall GHG emission rate when expressed as CO_2 equivalents. This emission rate varies slightly among different models of generator sets. The maximum recent annual CO_2 emissions from diesel-fueled generator sets operated by reliability-based program participants during demand response events was about 911 tons. This estimate is based on the assumption that the generator sets generated 1,111 MWh during the demand response events. The Tier 4 Emission Standards listed above in Table 3.3 do not address emissions of CO_2 or other GHGs and GHG emissions from diesel-fueled generator sets are not the subject of other current federal regulations.

Environmental Consequences

No Action Alternative: Under the No Action Alternative, the operation of diesel-fueled generator sets during demand response events would cease following the expiration of the current TVA demand response contracts. Demand response participants with diesel generator sets that do not meet the recent EPA emission standards have presumably already ceased operating their generator sets during demand response events. Participants with generator sets that meet the recent standards would presumably continue to operate them during demand response events for the duration of their demand response contracts. Their continued operation would result in the annual emission of up to several hundred tons of CO_2 and smaller amounts of other GHGs. The eventual elimination of all diesel-fueled generator sets during demand response events would have a negligible effect on the projected decreasing trend in CO_2 emissions from the TVA power system and the environmental impacts of those emissions. The impacts of emissions of CO_2 and other GHGs from the TVA power system are described in TVA (2015a).

Proposed Action Alternative: Under the Proposed Action Alternative, the use of diesel generation during demand response events by current demand response participants and the associated GHG emissions would decrease as some current participants have indicated they do not intend to modify or replace their generator sets to meet the new EPA standards. This decrease would be at least partially offset by the use of diesel-fueled generators during demand response events by participants in the reliability- and economic-based programs.

Based on the assumptions on the operation of diesel generators during demand response events as described in Section 2.2 and used for the calculation of emissions of air pollutants in Section 3.1, the anticipated near-term GHG emissions are listed in Table 3.8 and the anticipated GHG emissions at the currently planned maximum program expansion are listed in Table 3.9.

The projected annual near-term emissions of 1,100 tons of CO_2 from diesel-fueled generators operated during demand response events are a very small fraction (0.002 percent) of the TVA power system emissions of 79.4 million tons of CO_2 in 2015. At the currently proposed maximum demand response capacity increase of 50 percent, the CO_2 emissions from diesel-fueled generators operated during demand response events would comprise about 0.003 percent of the projected TVA power system emissions of 49 million tons of CO_2 in 2033 (TVA 2915a). The increased emissions of CO_2 and other GHGs from the continued and expanded operation of diesel-fueled generators during demand response events would have an imperceptible effect on TVA's long-term projected decrease in GHG emissions and the environmental impacts of those emissions.

Table 3.8. Near-Term Annual GHG Emission Estimates from Diesel-Fueled Generator Sets during Demand Response Events

Pollutant	Hourly lb/eng-hr	Annual tons/eng-yr	Annual tons/yr
Carbon dioxide (CO_2)	3,980	39.80	1,110
Methane (CH_4)	0.161	0.0016	0.045
Nitrous oxide (N_2O)	0.0323	0.0003	0.009
Greenhouse gases (GHG) as CO_2 equivalents (CO_2e)	3,990	39.90	1,120

Notes:

1 *lb/eng-hr* denotes pounds of pollutant emitted per engine per hour.

2 *tons/eng-yr* denotes tons of pollutant emitted per engine per year.

3 *tons/yr* denotes tons of pollutant emitted by 28 2-MW diesel-engine generators per year

Table 3.9. Annual GHG Emission Estimates from Diesel-Fueled Generator Sets Assumed during Demand Response Events at Maximum Program Expansion

Pollutant	Hourly lb/eng-hr	Annual tons/eng-yr	Annual tons/yr
Carbon dioxide (CO_2)	3,980	67.70	1,560
Methane (CH_4)	0.161	0.0027	0.063
Nitrous oxide (N_2O)	0.0323	0.0005	0.013
Greenhouse gases (GHG) as CO_2 equivalents (CO_2e)	3,990	67.9	1,570

Notes:

1 *lb/eng-hr* denotes pounds of pollutant emitted per engine per hour.

2 *tons/eng-yr* denotes tons of pollutant emitted per engine per year.

3 *tons/yr* denotes tons of pollutant emitted by 44 2-MW diesel-engine generators per year

3.3 Noise

Affected Environment – Noise is generally described as unwanted sound that is usually caused by human activity. Sound is usually measured on a logarithmic scale with a unit called the decibel (dB). Due to the logarithmic scale, an increase of 10 dB would be perceived as being twice as loud. Sound on the decibel scale is referred to as sound level which may be weighted according to the use of the sound level data. The A-weighted decibel (dBA) is most commonly used for noise planning purposes and represents the approximate frequency response of the average young human ear. Many communities have noise ordinances which set maximum allowable sound levels for different land use types and times of day. Metropolitan Nashville, for example, has maximum noise levels of 75 dBA at the property line of industrial and agricultural areas during both day and night, and 65 dBA during the day and 60 dBA at night at the property line of other types of land uses (MGNDC 2016). Knoxville, Tennessee has a maximum noise level of 80 dB on the C-scale at the property line for industrial areas (City of Knoxville 2016). Many parts of the TVA region have no noise ordinances or have ordinances that prohibit certain types of noises but do not set maximum noise levels. The Occupational Safety and Health Administrations has set noise standards for commercial and industrial facilities that are primarily aimed at protecting worker health. These standards may be met by the use of hearing protection equipment by workers or other measures that do not necessarily reduce offsite sound levels. The USEPA has established a 24-hour exposure level of 70 dBA as necessary to avoid potential long-term effects to hearing (USEPA 1974).

Operating diesel-fueled generator sets produce noise from the engine, the cooling fan, the engine exhaust, mechanical vibration, and other sources. Without measures to control the sound, generator sets can produce noise levels of 100 dBA or more at a distance of 21 feet. Depending on the model of generator set, available methods of reducing the noise level include acoustic barriers and insulation, isolation mounts, inlet and outlet air baffles, and exhaust silencers. These methods, along with careful placement of the generator set on the industrial or commercial site, can reduce generator set noise to levels that comply with local noise ordinances. Noise levels for the individual diesel generator sets operated by demand response program participants are not known and they are assumed to comply with all applicable ordinances and regulations.

Environmental Consequences

No Action Alternative: Under the No Action Alternative, demand response program participants with qualifying diesel generators would continue to operate the diesel generators during demand response events for the remainder of their current contracts with TVA, as well as at other times such as power outages. Following the expiration of the current TVA contracts, demand response participants would no longer operate diesel-fueled generator sets during demand response events. This would reduce, but not eliminate, the noise from diesel generator sets which would presumably continue to operate for other purposes. This would likely result in a small decrease in ambient noise levels at some participants' facilities.

Proposed Action Alternative: Under the Proposed Action Alternative, there would likely be somewhat less use of diesel generation during demand response events that at present, with an associated decrease in noise from diesel generators. Over the longer term at maximum program expansion, the use of diesel generators and the associated noise could increase by up to about 50%. Most of the increase in noise impacts would result from the operation of diesel generators during demand response events by new program participants. Because these generators would have been installed primarily for purposes other than use during demand response events, the maximum program expansion projected under the Proposed Action Alternative would result in increased operating hours of existing diesel generators and not result in new noise sources. The existing diesel generators are assumed to meet all applicable noise ordinances and regulations and their use during demand response events would have insignificant effects on local ambient noise levels.

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