Air Emissions from the University of Kansas, Lawrence Campus

Prepared by the KU-LC Department of Environment, Health & Safety

The University of Kansas, Lawrence Campus (KU-LC) continually monitors the amounts of air pollutant emissions produced on the Lawrence Campus. Specifically, the KU-LC Department of Environment, Health & Safety monitors the amounts of fossil fuels (e.g., natural gas and diesel oil) combusted on the campus by stationary sources (e.g., boilers) from which the amounts of air pollutants emitted during the year are calculated.

The legal authority for federal programs regarding air pollution control is based on the 1990 Clean Air Act (CAA) Amendments which modified and extended federal legal authority provided by the earlier Clean Air Acts of 1963 and 1970. Among other things, this law authorized the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards to regulate emissions of six “criteria air pollutants” (ozone, particulate matter, carbon monoxide, nitrogen oxide, sulfur dioxide, and lead). The law also established the National Emission Standards for Hazardous Air Pollutants to regulate a second category of pollutants, “hazardous air pollutants” (HAPs) (e.g., benzene, trichloroethylene, mercury, chromium, and dioxin). In regard to criteria air pollutant emissions, a “major source” is defined as a facility that has the potential to emit more than 100 tons of a criteria air pollutant annually from stationary sources. For HAPs, a major source is a facility that has the potential to emit more than 10 tons annually of any one HAP or 25 tons of all HAPs combined from a stationary source or group of sources. “Area sources” are those facilities that have the potential to emit annually more than 25 tons of criteria air pollutants but less than 100 tons from stationary sources. Area sources are also defined as sources that have the potential to emit annually less than 10 tons of a single HAP or less than 25 tons of a combination of HAPs. The CAA requires major sources to apply for and receive a permit to operate.

To determine if KU-LC was a major source, the University conducted a thorough evaluation of its potential to emit annually both criteria air pollutants and HAPs. That evaluation determined that KU-LC had the potential to emit more than 100 tons annually of each of three criteria pollutants (sulfur dioxide, nitrogen oxides, and carbon monoxide). Therefore, the KU-LC is considered a major source under the CAA. That evaluation also found that the KU-LC did not have the potential to emit more than 10 tons annually of any singular form of HAPs or a combined 25 tons of HAPs, which mean the KU-LC would be an area source in regard to those types of emissions.

The University applied for and received a Class II Operating Permit from the Kansas Department of Health and Environment (KDHE). That permit provides limits on the amounts of fuel (i.e., natural gas and fuel oil) to be used by the stationary air pollution sources (e.g., boilers) to maintain their annual emissions of criteria pollutants below the major source thresholds. There are three criteria air pollutants that are listed in the KU-LC's Class II Permit for which annual emissions limits are set: sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO). As stipulated in that permit, the University submits an annual "Emissions Inventory Report" to KDHE. In that report, the amounts of fossil fuels used by stationary sources during the calendar year are provided. These data are converted by KDHE to the amounts of each regulated criteria air pollutant to confirm the University is within its regulatory Class II Permit limits (i.e., less than 100 tons per year of each criteria pollutant).

The reason why the Congress of the United States passed the CAA was to protect and enhance the quality of the Nation's air resources so as to first, promote public health and welfare and second, to maintain the productive capacity of its population. Each of the three criteria air pollutants listed in KU-LC's Class II Permit have the potential to cause both human health and environmental harm.

Current scientific evidence has linked sulfur dioxide (SO_2) to human health problems such as changes in pulmonary function and an array of adverse respiratory effects including bronchoconstriction and increased asthma symptoms. SO_2 can also react with compounds in the atmosphere (e.g., hydroxyl ions, water, oxygen, and ammonia) to form small particles (e.g., sulfate particles). These particles can penetrate deeply into sensitive parts of the lungs and cause or worsen respiratory diseases, such as emphysema and bronchitis, the two major main subtypes of chronic obstructive pulmonary disease (COPD), and aggravate existing heart disease, leading to increased hospital admissions and premature death. Furthermore, SO_2 emissions can cause environmental harm. SO_2 mixes with water vapor and oxygen in the atmosphere producing sulfuric acid. The result is acidic atmospheric pollution deposited as acid rain. Acid rain can harm lakes and streams making them acidic and unsuitable for many fish and other organisms to survive. Also, acid rain can damage buildings and structures (especially those made from limestone), soils, plants, and forests.

Nitrogen oxides (NO_x) can also cause human health problems. NO_x consists of nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous oxide (N_2O). These compounds are formed when nitrogen (N_2) combines with oxygen (O_2) as fossil fuel is combusted. NO_x, in themselves, are harmful to the respiratory systems of humans. Furthermore, NO_x reacts with ammonia, water, and other compounds to form nitric and nitrous acids. These acidic forms have human health concerns including effects on breathing and the respiratory system, damage to lung tissue, decreased pulmonary function, and premature death. The main reason NO_x is considered a human health hazard is because it initiates reactions that result in the production of ozone (O_3). Ground-level ozone is the prime ingredient of smog. Breathing ground-level ozone can result in respiratory problems, reduced lung function, changes in pulmonary function, and inflammation of the airways. Evidence strongly indicates that higher daily ozone concentrations are associated with increased asthma attacks, increased hospital admissions, increased mortality, and other markers of morbidity. There are also environmental impacts of ozone. Ground-level ozone interferes with the ability of plants to produce and store food, so that growth, reproduction, and overall plant health are compromised. Ground-level ozone also reduces agricultural yields for many economically important crops and effects long-lived species (e.g., trees) such that whole forests or ecosystems. As mentioned earlier, NO_x, like SO_2, mix with water vapor in the atmosphere producing nitric and/or nitrous acid, thereby contributing to acid rain and its negative environmental impacts.

Carbon monoxide (CO) can cause harmful human health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death. For people who have several types of heart disease and already have reduced capacity for pumping oxygenated blood throughout their bodies, there is a risk of experiencing myocardial ischemia (reduced oxygen to the heart), chest pain (angina), and congestive heart failure, especially when these people are exercising or under increased stress. Environmental impacts of CO include its effect on greenhouse gases. Although carbon monoxide is only a weak greenhouse gas, its presence affects concentrations of other, much stronger, greenhouse gases including carbon dioxide (CO_2) and methane (CH_4). CO readily reacts with hydroxyl radicals (OH^-) in the atmosphere forming a stronger greenhouse gas — CO_2. The end result of the reaction of CO with OH^- is an increase in the concentration of another very strong greenhouse gas — CH_4. The most common way CH_4 is removed from the atmosphere is when it reacts with OH. Therefore, when CO reacts with OH^- to form CO_2, fewer OH are available for CH_4 to react with thereby increasing the concentration of CH_4.

Beginning in 2010, the University of Kansas began submitting a second air emissions report concerning greenhouse gases (GHG) to the EPA each year. This reporting is required under the EPA Mandatory Reporting of Greenhouse Gases Rule, the implementation part referred to as the Greenhouse Gas Reporting Program (40 CFR Part 98). The purpose of the rule is to provide accurate and timely GHG information to inform future policy decisions. This reporting is required of any facility that emits 31,000 metric tons of equivalent carbon dioxide (CO_2e) or more per year in combined emissions from stationary fuel combustion units (e.g., boilers). Using the units of CO_2e is a way of normalizing the level of radiative forcing (the difference between solar energy absorbed by Earth and that radiated back to space, the warming potential) by any type and concentration of a greenhouse gas to an equivalent amount of CO_2. Greenhouse gases have a positive effect on radiative forcing, thereby warming the system (i.e., the Earth). For example, a molecule of CH_4 has approximately 25 times more of a positive effect on radiative forcing than a molecule of CO_2; therefore, one molecule of CH_4 would have a CO_2e of 25. The KU-LC exceeds the 25,000 ton per year limit of CO_2e, therefore, the University submits a GHG report each year (Table 1, Figure 1).

The KU-LC continues to implement actions to reduce the amounts of criteria air pollutants and HAPs. The Class II Operating Permit for KU-LC set the annual emission limit for NO_x at 77.53 tons per year. Currently, the KU-LC annual emissions of NO_x are only 28% of that limit (2020 – 21.5 tons NO_x/year) (Table 1 and Figure 2). Of the seven major boilers at KU-LC as of 2020, six have now been fitted with low-NO_x burners which reduce the amount of NO_x emissions by approximately 70%. Generally, low-NO_x burners work by reducing the peak flame temperature which results in less NO_x formation. As older boilers are replaced, refurbished, or if new boilers are added, these boilers will be installed with low-NO_x burners to keep the amount of this criteria air pollutant to a minimum. Annual emissions of the other two criteria pollutants listed in the permit, CO and SO_2, are also very much below the major source threshold (100 tons/year) (Table 1, Figures 3 and 4).

Table 1. KU-LC annual emissions of the three criteria pollutants regulated by the Class II Operating Permit and greenhouse gas equivalents (CO_2e).

Year	NO_x (tons)	CO (tons)	SO_2 (tons)	CO_2e (10^3 tons)
2010	29.0	24.4	0.175	31.5
2011	28.7	24.2	0.174	31.1
2012	21.9	20.8	0.149	26.8
2013	26.5	24.6	0.176	31.7
2014	23.3	24.2	0.173	31.3
2015	22.2	21.9	0.157	27.7
2016	20.4	20.3	0.146	26.4
2017	17.7	20.2	0.143	25.7
2018	21.2	24.6	0.18	31.8
2019	25.4	26.3	0.19	34.2
2020	21.5	24.1	0.17	31.0

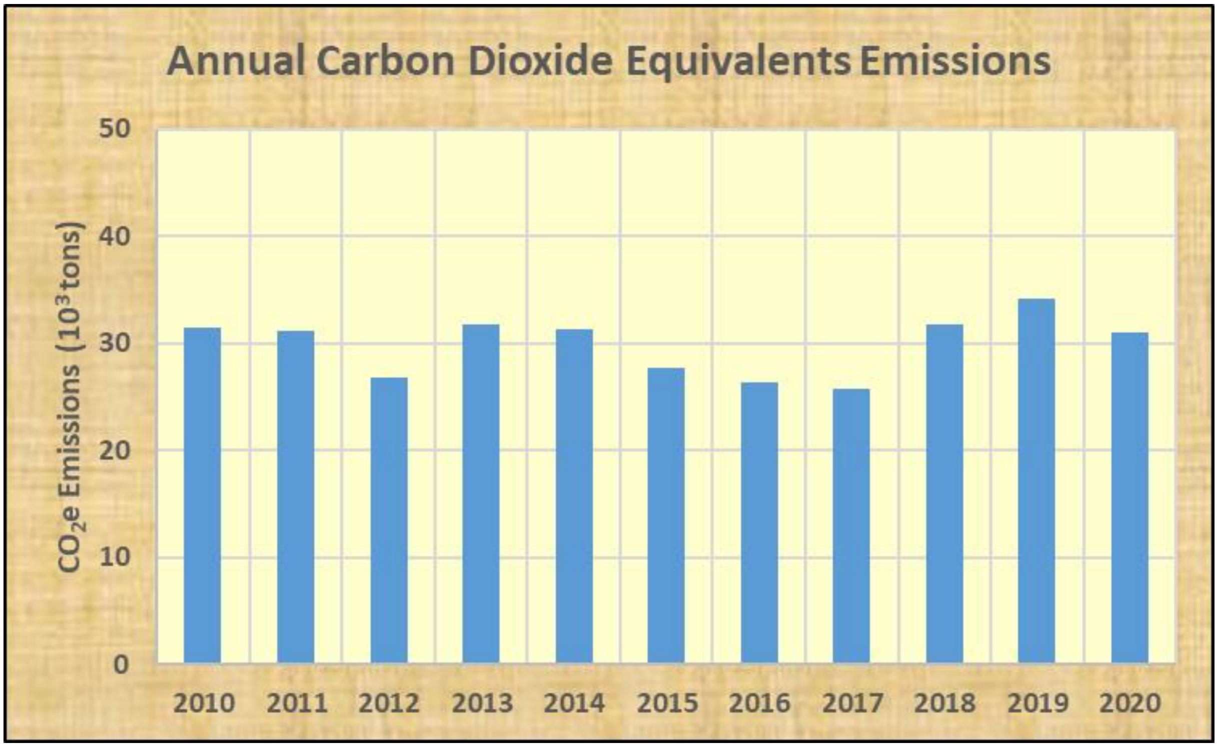

Figure 1. KU-LC annual carbon dioxide equivalents (CO_2e) emissions (2010 – 2020).

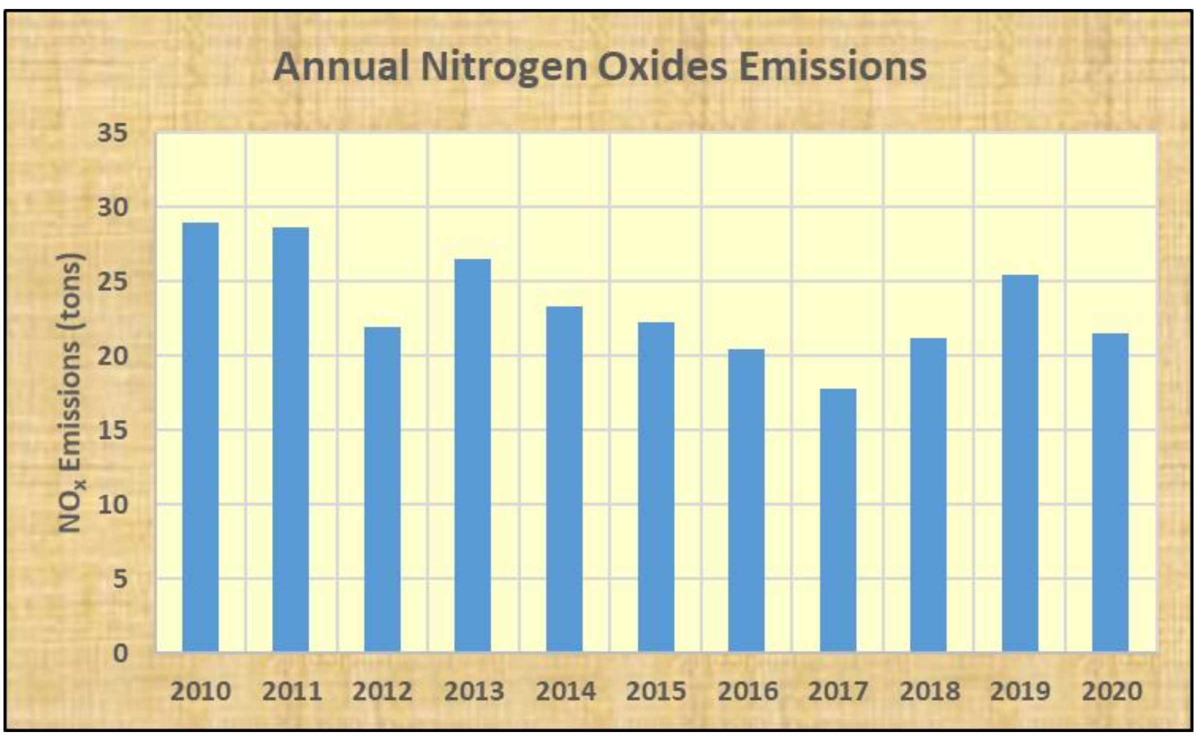

Figure 2. KU-LC annual nitrogen oxides (NO_x) emissions (2010 – 2020).

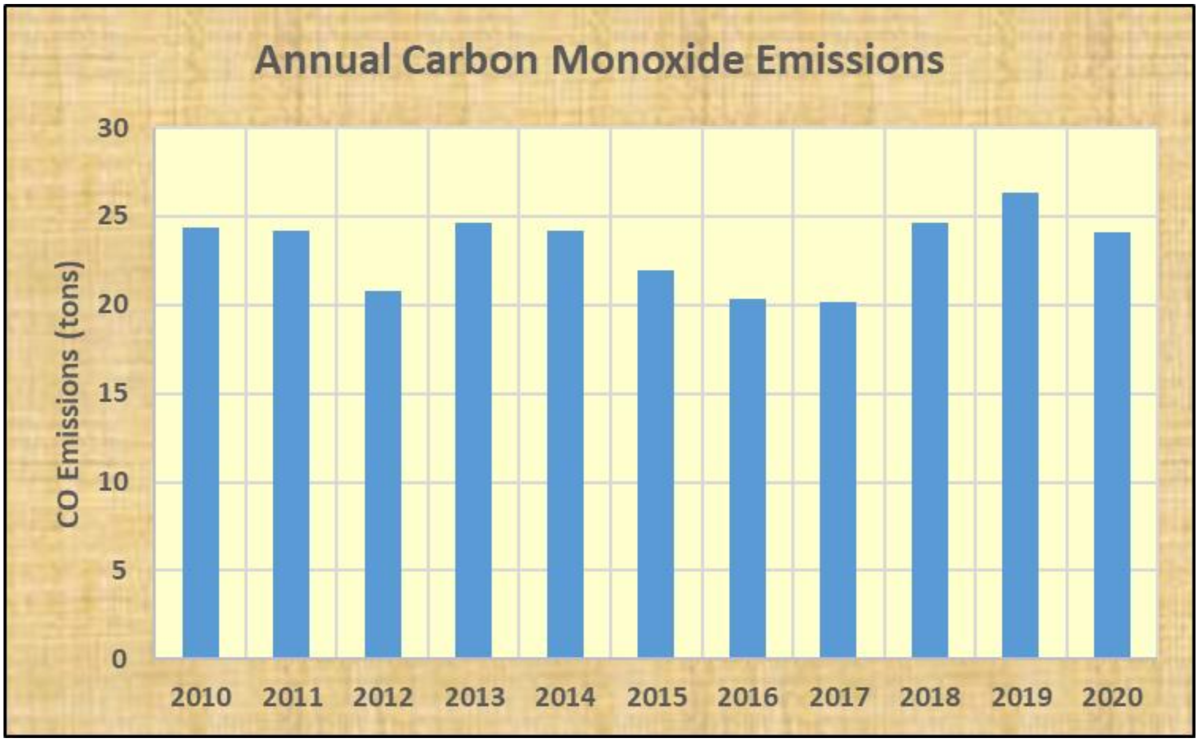

Figure 3. KU-LC annual carbon monoxide (CO) emissions (2010 – 2020).

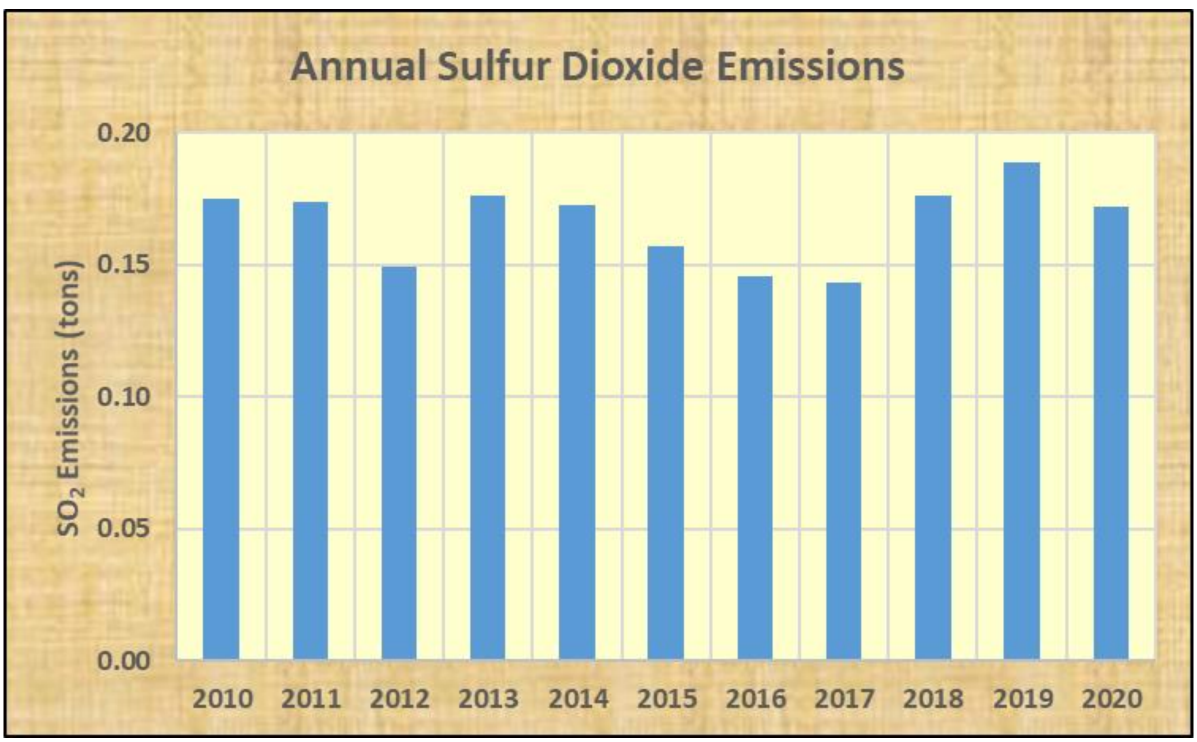

Figure 4. KU-LC annual sulfur dioxide (SO_2) emissions (2010 – 2020).