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Basis for Denial of Petitions to Reconsider and Petitions to Stay the CAA section 111(d) Emission Guidelines for Greenhouse Gas Emissions and Compliance Times for Electric Utility Generating Units

Appendix 4 — Climate Science Update

U.S. Environmental Protection Agency

Climate Science Update

The Clean Power Plan was published in the Federal Register on October 23rd, 2015. Since that time, the EPA has finalized another priority regulatory action informed by climate change science. On July 25, 2016, EPA Administrator McCarthy signed two findings under section 231(a)(2)(A) of the Clean Air Act (CAA, or Act). Those findings were that: (1) concentrations of six well-mixed greenhouse gases (GHGs) in the atmosphere endanger the public health and welfare of current and future generations (the endangerment finding), and (2) GHGs emitted from certain classes of engines used in certain aircraft are contributing to the air pollution—the mix of those six GHGs in the atmosphere—that endangers public health and welfare (the cause or contribute finding, or contribution finding). [1] The Administrator made these findings using the same definitions of the "air pollution" and "air pollutant" as was used under CAA section 202(a)(1) regarding motor vehicle GHG emissions (2009 Findings, 74 FR 66496), namely the combined mix of six key well-mixed GHGs: carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The findings made under CAA section 231(a)(2)(A) were published in the *Federal Register* on August 15, 2016 (81 FR 54422), and became effective on September 14, 2016 (2016 Findings).

In the 2009 Findings, the EPA concluded that GHG emissions from new motor vehicles cause or contribute to the air pollution that causes climate change endangering public health and welfare. In the 2016 Findings under CAA section 231(a)(2)(A), EPA is informed by and placed considerable weight on the extensive scientific and technical evidence in the record supporting the 2009 Findings under section 202(a) of the CAA, including the major, peer-reviewed scientific assessments (primarily those of the National Academies, the U.S. Global Change Research Program (USGCRP), and the International Panel on Climate Change (IPCC)) used to address the question of whether GHGs in the atmosphere endanger public health and welfare, and on the analytical framework and conclusions upon which the EPA relied in making the 2009 Findings. The 2016 Findings for aircraft under section 231(a)(2)(A) account for the EPA's careful consideration of the scientific and technical record for the 2009 Findings, the new, major scientific assessments issued since closing the administrative record for the 2009 Findings, and public comments. In making the 2016 Findings, EPA found that "the[] … [science] assessments [since the 2009 Endangerment Finding] are largely consistent with, and in many cases strengthen and add to, the already compelling and comprehensive scientific evidence detailing the role of the six well-mixed GHGs in driving climate change, explained in the 2009 Endangerment Finding." 80 Fed. Reg. at 54,442. EPA added that the "science assessments released since 2009 … strengthen and further support the judgment that GHGs in the atmosphere may reasonably be anticipated to endanger the public health and welfare of current and future generations. No information or assessments published since late 2009 suggest that it would be reasonable for the

[1] The contribution finding concludes that GHG emissions from certain classes of engines used in "U.S. covered aircraft" contribute to the air pollution that endangers public health and welfare. The EPA defines "U.S. covered aircraft" to be subsonic jet aircraft with a maximum takeoff mass (MTOM) greater than 5,700 kilograms and subsonic propeller driven aircraft (e.g., turboprops) with a MTOM greater than 8,618 kilograms. This contribution finding for engines used in U.S. covered aircraft results in the vast majority (89 percent) of total U.S. aircraft GHG emissions being included in this determination.

EPA to now reach a different or contrary conclusion for purposes of CAA section 231(a)(2)(A) than the Agency reached for purposes of section 202(a)." 80 Fed. Reg. at 54,424.

The science regarding the impacts of climate change has also continued to advance since publication of the CPP. Major assessments have been released by the USGCRP and the National Academy of Sciences, as well as the annual State of the Climate report from NOAA. The major assessments demonstrate the continued and, for certain outcomes, increased certainty and likelihood that GHGs impact health and welfare now and in the future. As laid out in the 2009 Findings, it continues to be EPA's view that the scientific assessments of the IPCC, USGRCP, and the National Research Council represent the best reference materials for determining the general state of knowledge on the scientific and technical issues before the agency in making an endangerment decision. No other source of information provides such a comprehensive and in-depth analysis across such a large body of scientific studies, adheres to such a high and exacting standard of peer review, and synthesizes the resulting consensus view of a large body of scientific experts across the world. These assessments draw synthesis conclusions across thousands of individual peer-reviewed studies that appear in scientific journals, and the reports themselves undergo additional peer review. This provides assurance that the Administrator is basing her judgment on the best available, well-vetted science that reflects the consensus of the climate science research community. In addition, EPA's consideration of the major assessments to inform the Administrator's judgment allowed for full and explicit recognition of scientific uncertainty regarding the endangerment posed by the atmospheric buildup of GHGs. All the likelihood and confidence language used in the assessment reports when reporting conclusions take into account the uncertainties discussed in the underlying literature. For these reasons, the EPA places primary and significant weight on these assessment reports in reviewing the state of climate science. EPA places limited weight on the much smaller number of individual studies or reports that have not been considered or reflected in the major assessments. EPA reviews them largely to see if they would lead EPA to change or place less weight on the judgments reflected in the assessment reports. EPA recognizes that some studies are more useful or informative than others, and it gives each study it reviewed the weight it is due, but in almost all cases the assessment reports remain the source of the conclusions and judgments that EPA makes. The assessments reflect extremely high quality, rigorous work that has gone through an exacting standard of peer review. The understanding of the climate system and the effects of elevated concentrations of GHGs on that system is remarkable given the complexity and uncertainties involved. As the National Academies explain in "Climate Change, Evidence & Causes", the science is clear regarding the contribution of humans to observed climate change, and that "if emissions of greenhouse gases continue unabated, future changes will substantially exceed those that have occurred so far".

In April of 2016 the USGCRP released "The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment" (the Climate and Health Assessment).[2] As

[2] USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp. http://dx.doi.org/10.7930/J0R49NQX

a USGCRP assessment, this document is consistent with EPA's approach to relying primarily on the major assessments of the USGCRP, the IPCC, and the National Academies to provide the technical and scientific information to inform EPA's GHG regulatory actions. In particular, this assessment concentrates on the impacts of climate change on human health in the United States, which is directly relevant to the question of whether elevated concentrations of GHGs can be reasonably anticipated to endanger human health and welfare. This assessment finds that—

> Climate change is a significant threat to the health of the American people. The impacts of human-induced climate change are increasing nationwide. Rising greenhouse gas concentrations result in increases in temperature, changes in precipitation, increases in the frequency and intensity of some extreme weather events, and rising sea levels. These climate change impacts endanger our health by affecting our food and water sources, the air we breathe, the weather we experience, and our interactions with the built and natural environments. As the climate continues to change, the risks to human health continue to grow.

Moreover, the assessment states that in the United States we have "observed climate-related increases in our exposure to elevated temperatures; more frequent, severe, or longer lasting extreme events; diseases transmitted through food, water, or disease vectors such as ticks and mosquitoes; and stresses to mental health and well-being." The assessment determines that "[e]very American is vulnerable to the health impacts associated with climate change" and "[w]hile all Americans are at risk, some populations are disproportionately vulnerable, including those with low income, some communities of color, immigrant groups (including those with limited English proficiency), Indigenous peoples, children and pregnant women, older adults, vulnerable occupational groups, persons with disabilities, and persons with preexisting or chronic medical conditions." The assessment finds that almost all of the assessed threats "are expected to worsen with continued climate change", with limited examples of potentially beneficial changes that are often limited to specific regions or populations. The assessment finds that "rising temperatures will lead to an increase in heat-related deaths and illnesses", that increased coastal and inland flooding will expose the population to a range of negative health impacts before, during, and after events, and that climate change will have impacts on both the geographic scope and seasonal timing of vector-borne disease outbreaks. Climate change is expected to "increase human exposure to chemical contaminants in food through several pathways" and rising carbon dioxide concentrations will lower the nutritional value of important food crops such as wheat and rice. Climate warming will also likely "make it harder for any given regulatory approach to reduce ground-level ozone pollution," and, unless offset by reductions of ozone precursors, it is likely that "climate-driven increases in ozone will cause premature deaths, hospital visits, lost school days, and acute respiratory symptoms."

"Climate Change, Global Food Security, and the U.S. Food System"[3], another USGCRP assessment, was released in December of 2015. This assessment concluded that climate change

[3] Brown, M.E., J.M. Antle, P. Backlund, E.R. Carr, W.E. Easterling, M.K. Walsh, C. Ammann, W. Attavanich, C.B. Barrett, M.F. Bellemare, V. Dancheck, C. Funk, K. Grace, J.S.I. Ingram, H. Jiang, H.

is "likely to diminish continued progress on global food security" through production and transportation disruptions, diminished food safety, decreasing access to food, and other causes, with the greatest risks accruing to the global poor and in tropical regions. The assessment did note that in the short term, some high-latitude production export regions might benefit from longer growing seasons. The assessment found that consumers and producers in the U.S. would be impacted through changes in the type and price of food imports, and changes in export demands and global trade. The assessment highlighted the potential for adaptation to manage climate-change effects, but also warned that the existence of potential adaptation measures does not ensure their application.

Another major science assessment released in 2016 was the National Academies report, "Attribution of Extreme Weather Events in the Context of Climate Change."[4] This report investigated the possibility of determining the extent of the influence of climate change on *individual* weather or climate events. The assessment noted that this area of science is rapidly advancing as better understanding of climate and weather and progress in attributing events have combined to allow for determinations to be made that would have been challenging in the recent past. The report determined that confidence is greatest for extreme event types that have a long-term historical record of observations, that are adequately simulated in climate models, and that occur in circumstances where non-weather contributing factors do not exist or can be reliably accounted for. The report concluded that the greatest confidence in attribution was true for extreme cold and heat events, followed by extreme drought and rainfall events. The report recognizes the advances in attributing individual events and recommends further research in this area, along with careful attention to how conclusions regarding attribution of single events are communicated.

The climate assessments have also considered the question of carbon budgets for any given temperature target. Because of the extremely long lifetime of carbon dioxide in the climate system, it has been shown, as stated by the IPCC 5th Assessment Report, that "[c]umulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond". The IPCC determined that to have a 50% chance of staying below 2 degrees warming compared to the late 19th century, cumulative CO_2 emissions would need to stay below 1210 gigatons of carbon. To stay below that target with greater certainty, or when accounting for likely increases in forcing from non-CO_2 greenhouse gases, the allowable CO_2 emissions would be reduced even further, to as little as 790 gigatons of carbon for a 2 in 3 chance of staying below 2 degrees and limited growth in non-CO_2 greenhouse gases. The IPCC determined that for higher temperature targets, the concept of a limited budget still applied, though the allowable carbon emissions would be higher. Similarly, the National Academies Climate Stabilization Targets assessment determined that emissions of 1150 gigatons of carbon was the most consistent with a 2 degree future (with a very likely range of 500 gigatons to 1900 gigatons,

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Maletta, T. Mata, A. Murray, M. Ngugi, D. Ojima, B. O'Neill, and C. Tebaldi. 2015. Climate Change, Global Food Security, and the U.S. Food System. 146 pages. Available online at http://www.usda.gov/oce/climate_change/FoodSecurity2015Assessment/FullAssessment.pdf.

[4] National Academies of Sciences, Engineering, and Medicine. 2016. Attribution of Extreme Weather Events in the Context of Climate Change. Washington, DC: The National Academies Press. doi: 10.17226/21852.

depending on how the climate system responds). The National Academy's assessment determined that every additional 1000 gigatons of carbon would lead to a best estimate of 1.75 degrees more warming, so a three degree target would have a budget of about 1750 gigatons of carbon. About 515 gigatons of carbon have already been emitted by humans as of 2011, and about 10 gigatons of carbon are being emitted annually.

Finally, ongoing scientific measurements demonstrate that the climate has continued to change. Carbon dioxide concentrations continue to rise. The average concentration on top of Mauna Loa in 2014, the last full year before the CPP was finalized, was 399 parts per million. In 2015, the concentration grew by more than 2 parts per million, reaching an annual average of 401 ppm[5]. In their annual State of the Climate Report, NOAA documented a number of continuing changes: global sea level has continued to rise at a rate of 3.3 mm/year since the satellite record started in 1993 (compared to a rate of 3.2 mm/year from 1993 to 2014); Arctic sea ice continues to decline; glaciers continue to melt; global ice and snow cover continue to decline; and the oceans continue to become more acidic. 2015 was the warmest year in the global surface temperature record going back to 1880, exceeding 1 degree Celsius of warming and surpassing the previous record set in 2014, with 2016 certain to substantially exceed 2015. This now means that the last 16 years have been 16 of the 17 warmest years on record.[6] These observations demonstrate the continued dramatic changes in climate that the Earth has been experiencing in recent decades.

[5] ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_annmean_mlo.txt

[6] Blunden, J. and D. S. Arndt, Eds., 2016: State of the Climate in 2015. Bull. Amer. Meteor. Soc., 97 (8), S1–S275, DOI:10.1175/2016BAMSStateoftheClimate.