STATE OF NEW YORK

PUBLIC SERVICE COMMISSION

Case 13-E-0030:	Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Consolidated Edison Company of New York, Inc. for Electric Service
Case 13-G-0031	Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Consolidated Edison Company of New York, Inc. for Gas Service
Case 13-G-0031	Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Consolidated Edison Company of New York, Inc. for Steam Service

Direct Testimony of Dr. Radley Horton

On Behalf of

Center for Climate Change Law

And

Environmental NGO Group

Environmental Defense Fund, Natural Resources Defense Council, Pace Energy and Climate Center, and the Center for Climate Change Law at Columbia

May 31, 2013

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IDENTIFICATION AND QUALIFICATIONS

1. Please state your name and business address.

1-A. Radley Horton

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2. On whose behalf are you testifying?

2-A. I am testifying on behalf of the Center for Climate Change Law at Columbia Law School (CCCL). CCCL is also part of the Environmental NGO Group, an alliance of environmental non-profit organizations participating in the Consolidated Edison rate case.

3. By whom are you employed and in what capacity?

3-A. I am employed by Columbia University as an Associate Research Scientist at the Center for Climate Systems, part of Columbia University's Earth Institute.

4. Please summarize your qualifications.

4-A. At the Center for Climate Systems Research, I have developed climate information for a variety of types of decision makers, especially in support of impact assessment and adaptation. I have a Ph.D. and an M.S. from Columbia University in Earth and Environmental Sciences. I have co-authored numerous articles on climate change projections and impact assessments as well as articles on the implications for adaptation and planning efforts, including articles on coastal adaptation for infrastructure, sea level rise projection methods, climate hazard assessments in New York City, and resilient adaptation planning. My resume is provided as Exhibit ____, RH-1.

5. Please describe the New York City Panel on Climate Change (NPCC), its purpose and products, and your role on the Panel.

5-A. I was the Climate Science Lead for the New York City Panel on Climate Change (NPCC) Technical Group. In 2008, New York City Mayor Michael Bloomberg convened the NPCC. The NPCC, which consists of leading climate change and impact scientists, academics, and private sector practitioners, was charged with advising the Mayor and the New York City Climate Change Adaptation Task Force on issues related to climate change and adaptation as it relates to infrastructure. Our 2010 Report, one of a series of products created for the Task Force, provided climate change projections for New York City and identified some of the potential risks to infrastructure posed by climate change. An updated report from the NPCC is expected to be released later this summer with the latest projections, but my remarks in this testimony are based on the 2010 report as it is the version currently publically available. The 2010 NPCC Report is provided as Exhibit ____, RH-2.

6. Please describe the U.S. Global Change Research Program (USGCRP), its purpose and products, and your role with the Program.

6-A. I am one of two Convening Lead Authors for the Northeast Chapter of the 2013-2014 National Climate Assessment.

The U.S. Global Change Research Program (USGCRP) is a federal program that coordinates and integrates global change research across 13 government agencies. USGCRP was established by presidential initiative in 1989 and mandated by Congress in the Global Change Research Act of 1990 in order to *"assist the nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change."*

The USGCRP develops many reports and products, including the National Climate Assessment (NCA), a status report about climate change science and impacts that is to be delivered to the President, Congress, and the public every four years. The NCA integrates information from across all of USGCRP's research activities to paint a comprehensive picture of the effects of global change on many sectors of society. It also analyzes trends in global climate change and predicts future changes up to 100 years down the road. The Second NCA was published in 2009, and the Third is expected to be completed in 2013 or 2014.

7. Have you previously testified before the New York State Public Service Commission ("the Commission")?

7-A. No.

I. INTRODUCTION AND SUMMARY

8. What is the purpose of your testimony in this proceeding?

8-A. I am testifying to highlight that climate conditions are projected to change in ways that are relevant to Con Edison's operations and that climate information and climate projections can inform long-term planning and decision-making.

9. Please summarize your testimony.

9-A. Climate change associated with increased human emissions of heat-trapping greenhouse gases poses a variety of hazards to New York City and New York State. As the 21st century progresses, extreme heat events are projected to become more frequent and intense, and sea level rise is projected to lead to increased coastal flooding. It is also likely that intense precipitation events will become more frequent. In light of these projected

changes, infrastructure is likely to be faced with a different range of environmental conditions than it has experienced in the past, and risk management efforts should be revised to account and prepare for altered conditions.

II. AMBIENT TEMPERATURE INCREASE

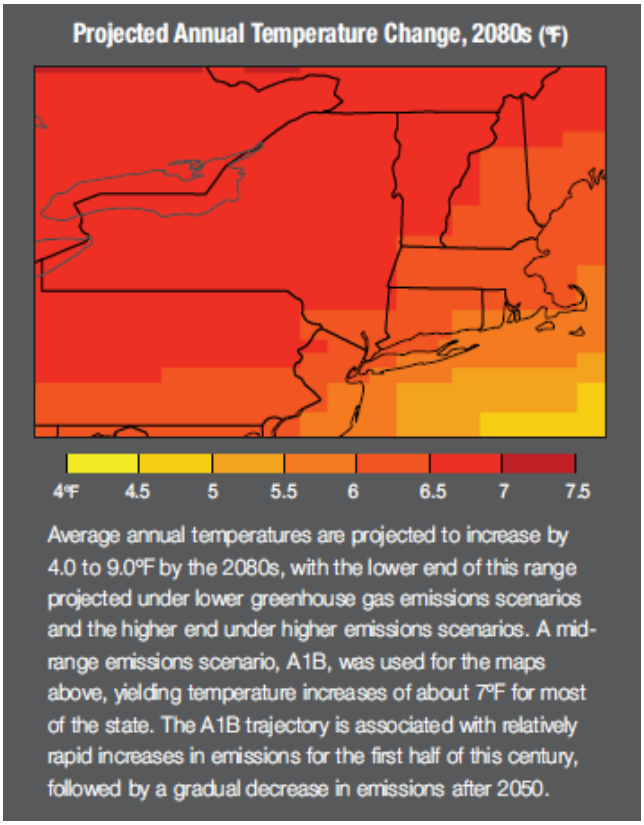
10. Have you studied the potential for ambient temperatures in New York State and New York City to increase due to climate change?

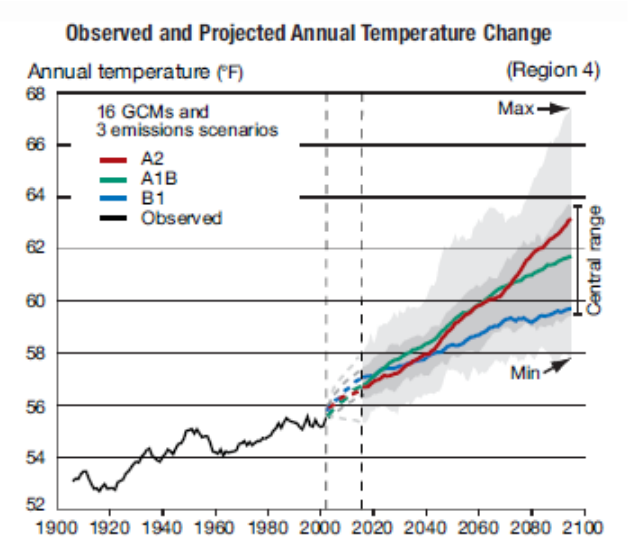
10-A. Yes. In 2010, the NPCC published a report in which we prepared climate change projections (including temperature increases) for New York City, examined how climate change and increased temperature would impact critical infrastructure, and proposed strategies for how the city can adapt. In 2010, the NPCC Report published the projected increases in temperature for New York City. In 2011, we published a report called "Response to Climate Change in New York State", also known as ClimAID, in which we prepared temperature projections for all of New York State. The ClimAID 2011 Report is provided as Exhibit _____, RH-3.

11. Based on your study, what is the projected increase in temperature for New York State and New York City between 2013 and 2100?

11-A. The projected increase in temperature is different for different regions of the state. Using the average annual temperature from 1971-2000 as a baseline, temperature increases across the state are projected to range from1.5-3.0°F by the 2020s, 3.0 to 5.5°F by the 2050s, and 4.0 to 9.0°F by the 2080s (ClimAID, 2011). The graphs below, excerpted from the ClimAID report, show the general trend and regional variability.

In New York City, the NPCC observed past trends and then modeled predictions for future temperature rise. During the 1971-2000 period, the average annual air temperature was 55°F, but by the 2020s this is predicted to increase by 1.5° to 3.0°F and by 3.0 to 5.0°F by the 2050s. The projected future temperature changes indicate that by the 2080s, New York City's mean temperature throughout a "typical" year may bear similarities to a city like Raleigh, North Carolina, or Norfolk, Virginia, today. Because year-to-year temperature variability is larger in winter than in summer, the summer changes may produce relatively larger deviations from what has been experienced historically during individual years.





Figures 1 and 2. Excerpted from the ClimAID 2011 Synthesis Report. Figure 1 (on the left) illustrates the projected change in annual temperature in New York State by the 2080s. Projected increases range from 5.5 to 7°F. Figure 2 (on the right) illustrates the observed change in temperature from 1900-2000 and projected changes in temperature from 2013 to

2100, with the different lines reflecting different greenhouse gas emissions. Even in the low emissions scenario, substantial temperature increase is still projected.

12. Based on your research, are New York State and City more likely to experience extreme heat events in the future?

12-A. Yes. New York State is projected to experience more individual days of extreme heat, as well as an increase in the frequency and duration of heat waves, defined as three consecutive days with maximum temperatures at or above 90°F. For example, between 1971 and 2000 the New York City region saw an average of 14 days a year with temperatures above 90°F, 0.4 days per year over 100°F, and two heat waves per year. This is projected to increase to 23 to 29 days by the 2020s, 29 to 45 days by the 2050s, and 37 to 64 days by the 2080s (NPCC, 2010). The number of heat waves is also projected to increase from 2 per year (1971-2000) to 4 to 9 per year by the 2080s (ClimAID, 2011).

Table 1 (below) from the NPCC 2010 Report, summarizes the baseline climate and mean annual changes projected in New York City.

	Baseline 1971–2000	2020s	2050s	2080s
Air temperature				
Central range[b]	55° F	+ 1.5 to 3.0° F	+ 3.0 to 5.0° F	+ 4.0 to 7.5° F
Precipitation				
Central range[b]	46.5 in[3]	+ 0 to 5%	+ 0 to 10%	+ 5 to 10%
Sea level rise[c]				
Central range[b]	NA	+ 2 to 5 in	+ 7 to 12 in	+ 12 to 23 in
Rapid ice-melt scenario[d]	NA	~ 5 to 10 in	~ 19 to 29 in	~ 41 to 55 in

Source: Columbia University Center for Climate Systems Research.
[a]Based on 16 GCMs (7 GCMs for sea level rise) and 3 emissions scenarios. Baseline is 1971–2000 for temperature and precipitation and 2000–04 for sea level rise. Data from National Weather Service (NWS) and National Oceanic and Atmospheric Administration (NOAA). Temperature data are from Central Park; precipitation data are the mean of the Central Park and La Guardia Airport values; and sea level data are from the Battery at the southern tip of Manhattan (the only location in New York City for which comprehensive historic sea level rise data are available).
[b]Central range = middle 67% of values from model-based probabilities; temperatures ranges are rounded to the nearest half-degree, precipitation to the nearest 5%, and sea level rise to the nearest inch.
[c]The model-based, sea level rise projections may represent the range of possible outcomes less completely than the temperature and precipitation projections.
[d]"Rapid ice-melt scenario" is based on acceleration of recent rates of ice melt in the Greenland and West Antarctic ice sheets and paleoclimate studies.

13. Have other studies also predicted increased temperature for the New York region?

13-A. Yes. Other studies including the US Global Change Report of 2009 do include temperature projections for the broader Northeast region. The US Global Climate Change Report of 2009 (the Second National Climate Assessment) reports that annual average temperature in the Northeast Region has increased by 2°F since 1970, with winter temperatures rising twice this amount, and that temperatures are projected to rise an additional 2.5 to 4°F in winter and 1.5 to 3.5°F in summer over the next several decades. It also adds, by late this century, under a higher emissions scenario, "Cities that today experience few days above 100°F each summer would average 20 such days per summer" and "hot summer conditions would arrive three weeks earlier and last three weeks longer into the fall." The Executive Summary and Northeast Regional chapter of the US Global Change Report of 2009 are provided as Exhibit ___, RH-4.

14. Given these projected increases in temperature, does it make sense to base a risk management plan for temperature on a past 30 year average of temperature?

14-A. No. By the time we reach the 2020s, we would expect higher temperatures and more frequent heat events than were observed in the past 30 year period. We will still have some years that have fewer hot days than average, as natural variability in the climate will continue. However, from a risk management perspective, the projections will have shifted sufficiently that it would be unwise to use the past 30 years as a precedent for future conditions.

III. SEA LEVEL RISE

15. Have you studied the rate of sea level rise in the coastal New York region?

15-A. Yes. I have been involved in several studies that have examined the rate of sea level rise in the coastal New York region. Our findings have been included in various papers, including ClimAID (2011) for coastal New York State, and NPCC (2010) for the New York City metro area.

16. Based on your study, what is the estimated sea level rise around New York State between 2013 and 2100?

16-A. Our NPCC sea level rise projections for New York State include several scenarios. The first scenario is based on global climate model output used in the IPCC 2007 Assessment. Under the regular global climate model (GCM) based scenario, sea level in the New York City and Long Island coastal region is projected to rise 2 to 5 inches by the 2020s, 7 to 12 inches by the 2050s, and 12 to 23 inches by the 2080s.

However, this scenario does not consider the potential for rapid changes in ice melt from the Greenland and Antarctic ice sheets. Thus, we also considered a scenario that is based on an acceleration of this process, which we refer to as a "rapid ice melt scenario". Under the rapid ice melt scenario, sea level is projected to rise 5 to 10 inches by the 2020s, 19 to 29 inches by the 2050s, and 41 to 55 inches by the 2080s (ClimAID, 2011).

The rapid ice scenario is just as plausible as the slow onset GCM-based scenario, so from a risk management perspective, it would be most effective to consider both possible scenarios. Other studies have confirmed that a worst-case scenario sea level rise situation could result in approximately 6 feet by 2100.[1] This is an upper bound, but it cannot be ruled out for major long-term infrastructure investments and risk management issues.

17. What variables affect the range of sea level rise projections?

17-A. Greenhouse gas emissions levels affect projected sea level rise, with more extreme sea level rise resulting from higher emissions scenarios. One variable affecting the range of sea level rise projections is the rate of ice melt in Greenland and Antarctica (discussed in my previous answer). There is also regional variation caused by factors including local land subsidence, and changes in the height of the ocean surface along the Northeast U.S. coast relative to the global ocean average. New York City experiences an extra 3 to 4 inches of sea level rise per century due to land subsidence. There is also some evidence from recent observations and models that the height of the ocean over the Northeast U.S. coast could rise more than the global ocean average.

[1] *See, e.g.,* A. Parris et al. Global Sea Level Rise Scenarios for the United States National Climate Assessment, NOAA Technical Report OAR CPO-1, Dec 6, 2012, available at cpo.noaa.gov/sites/cpo/Reports/2012/NOAA_SLR_r3.pdf.

18. Have other studies predicted elevated sea levels in the northeast region?

18-A. There have been various other recent studies which has examined sea level rise in the Northeast region. These studies look at sea level rise both as it will increase over time and at the relative rate of increase in the northeast compared to other regions. Examples include Yin et al. 2009, which modeled the effect of ocean circulation and described a range of dynamic sea level rise projections in the northeast region, and Sallenger et al. 2012, which describes historical accelerated sea level rise in a "hotspot" in the northeast region including New York City.[2]

19. What effect could elevated sea level have on floods and extreme weather events?

19-A. Higher sea levels increase the frequency and intensity of coastal flooding (including area inundated and depth of water) during coastal storms. Higher sea levels also can increase rainfall-induced flooding, by making it more difficult for rainwater flooding to drain into the sea.

20. Are there any studies on the effects of sea level rise on coastal flooding in the New York area?

20-A. Both the NPCC (2010) and ClimAID (2011) reports discuss the effects of sea level rise on coastal flooding in the New York area. According to the ClimAID report, "Sea level rise will lead to more frequent and extensive coastal flooding. Warming ocean waters raise sea levels through thermal expansion and have the potential to strengthen the most powerful storms…. Sea level rise in combination with a coastal storm that currently occurs about once

[2] *See, e.g.*, Yin, J., M.E. Schlesinger, and R.J. Stouffer, 2009. Model projections of rapid sea-level rise on the northeast coast of the United States. *Nature Geoscience*, 2, 262–266, doi: 10.1038/NGEO462, available at http://www.nature.com/ngeo/journal/v2/n4/abs/ngeo462.html; and Sallenger, A.H., K.S. Doran, and P.A. Howd, 2012. Hotspot of accelerated sea-level rise on the Atlantic coast of North America. Nature Climate Change 2, 884-888, doi: 10.1038/nclimate1597, available at http://www.nature.com/nclimate/journal/v2/n12/full/nclimate1597.html.

every 100 years on average is expected to place a growing population and more property at risk from flood and storm damage."

According to the NPCC predictions, what is currently a 1-in-10 year flood will recur on average once every 8 years by the 2020s, and a 1-100-year flood will recur once every 65-80 years. What this means is not that we will receive a strong storm every 65-80 years but that storms of significant severity will become increasingly probable under altered climate conditions.

21. Do the 2013 FEMA flood maps for New York State incorporate future projections of sea level?

21-A. No, the 2013 FEMA flood maps do not incorporate future projections of sea level. This means that they do not incorporate future risk areas but only reflect current vulnerability of coastal zones.

IV. EXTREME WEATHER EVENTS

22. Have you studied the effect of climate change on extreme weather events such as hurricanes, heavy precipitation events, snowstorms, and floods?

22-A. Yes. These effects are discussed in ClimAID (for New York State) and NPCC (for New York City).

23. What is the projected effect of climate change on extreme weather events?

23-A. Climate change is projected to result in an increase in the frequency, intensity and duration of heat waves (as discussed in my answer above). Since warmer air holds more moisture, precipitation tends to be concentrated in fewer, but more extreme, events. Thus, the frequency and severity of heavy precipitation and flooding events is projected to increase.

For example, in New York City, the number of days per year with over 1 inch of precipitation is projected to increase by 1 to 3 days by the 2080s. The frequency of the most intense hurricanes may increase as well (NPCC, 2010). Snowfall frequency and amount are likely to decrease as more precipitation will fall in the form of rain (NPCC, 2010), but if the air is cold enough the snowstorms that we do have could be more intense.

24. Could climate change make an event of Sandy proportions more likely in the future?

24-A. Sea level rise will increase coastal flooding associated with extreme storms. This means that even if storms do not change as the climate changes, coastal flooding will become more frequent and severe. The same storm hitting New York in the 2020s with increased sea level rise will produce greater coastal flooding.

The effect of climate change on storms themselves is less clear. It is known that warmer upper ocean levels provide fuel to storms like Sandy, and it is projected that upper levels of the ocean will continue to warm. However it is unclear how other factors that influence a storm like Sandy's strength, such as wind shear, may change in the future. There is some evidence to suggest that melting sea ice may play a role in the strength and position of the jetstream, which may in turn affect the path of storm systems, but this research is still in its early stages.

Sandy may have been a rare storm event, so preparing for a Sandy level of flooding plus the increase in coastal flooding due to predicted sea level rise would be a prudent action. But it would be necessary to add the sea level rise projections. Preparing for another Sandy alone would not be sufficient to address the increased coastal flooding that is predicted due to sea level rise and climate change. Also, some areas that were hit by Sandy were not at high tide,

so preparations should consider the possibility that Sandy's flooding could have been even worse in those areas.

25. Have other studies explored the connection between climate change and extreme weather events?

25-A. There are numerous studies which explore the connection between climate change and extreme events, most notably the Intergovernmental Panel on Climate Change (IPCC) Special Report on Extreme Events (SREX, 2012). According to the Summary for Policymakers, "A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events." The IPCC SREX 2012 Summary for Policymakers is provided as Exhibit ___, RH-5. Other reports that explore this connection are ClimAID (2011) for New York State, and NPCC (2010) for New York City.

26. Are there any studies that provide estimates of future wind events?

26-A. There is generally low confidence in projections of extreme winds because of the relative infrequency of extreme wind events, as well as flaws in the simulation of these events (SREX, 2012). However, the NPCC has made a qualitative statement that there is some evidence that the strongest hurricanes could become more frequent and intense in the North Atlantic ocean basin, and therefore the strongest wind events in the North Atlantic Ocean basin may also increase (ClimAID, 2011; NPCC, 2010).

V. PLANNING FOR FUTURE CLIMATE

27. Does the New York Panel on Climate Change (NPCC) Report conclude that climate is changing in New York State?

27-A. Yes. Both the NPCC and ClimAID reports conclude that the climate is changing in New York State, and I agree with these conclusions.

28. In your opinion, would a past 30 year average of New York weather accurately reflect the predicted future climate of New York State?

28-A. No. As greenhouse gas concentrations continue to rise, the climate of New York State and New York City is projected to change as well. By the 2020s, we would expect the climate of New York State and New York City to be statistically different from the climate we have experienced over the past 30 years. This difference will only increase as we move further into the 2050s, 2080s, and to 2100. Using the past 30 year average of weather as a benchmark for risk management would be unwise and contrary to our current scientific understanding.

29. How would you recommend that Con Edison prepare for future weather conditions?

29-A. I would encourage Con Edison to engage with scientists to understand the climate scenario predictions and what those predictions might mean for Con Edison's vulnerability. Based on these predictions, I would also encourage Con Edison to conduct a comprehensive evaluation of its current and projected future vulnerability both to temperature increase and extreme weather events. Long-term infrastructure investments should be guided by an understanding of the climate factors that the infrastructure will have to operate in. Con Edison should further regional coordination both with government agencies and with other utility companies to address these issues.

30. What scientific publications or resources would you recommend Con Edison use to understand future weather conditions?

30-A. For global and national context, the IPCC Assessment Reports, including the 2012 Special Report of Emissions Scenarios, and the USGCRP Third National Climate Assessment (due in early 2014) are recommended. For state and local information, the ClimAID Report and the NPCC Report provide more detailed predictions. As stated earlier, a new and updated version of the NPCC Report will be published in 2013, and Con Edison should refer to the most recent version of the NPCC Report (and any of the publications referenced above).

31. In light of the projected changes in temperature, sea level, and storm patterns, is infrastructure likely to be faced with a different range of environmental conditions than it has experienced in the past?

31-A. Yes. By the time we reach the 2020s, and to an even greater extent as we move into the second half of the century, the climate will be statistically different than it has been in the past. There will continue to be natural variability, such that some years will display climate very similar to that seen in the past 30 years, but there is also likely to be variability in the other direction such that we will see unprecedented temperatures, extreme weather events, and climate conditions. Infrastructure that we build today and that will still be operating in 20, 30, or 50 years, will have to operate in these changed conditions. This requires planning today in order to prepare for those conditions and consider the possible range of future environments.

32. Given these changes, are you aware of any studies or efforts by other jurisdictions to study and assess the need for climate change adaptation?

32-A. Yes. Many studies and reports on infrastructure adaptation and utility infrastructure have been published in recent years, but I will list a few examples here. A recent Government Accountability Office (GAO) report "Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers" (April 2013) addresses the need for greater adaptation in infrastructure development. The GAO report is provided as Exhibit ___, RH-6. In the private sector, Entergy Corporation, an integrated energy company, published a report on "Building a Resilient Energy Gulf Coast" (2010) that identified major sources of vulnerability in the region due to climate change. The Entergy Executive Summary is provided as Exhibit ___, RH-7. In Australia, a recent paper assessed the vulnerability of electricity utilities to climate change specifically: "Climate change adaptation and electricity infrastructure" (Lyster and Byrne, 2013). The Lyster and Byrne paper is provided as Exhibit ____, RH-8. These provide a small sampling of the type of reports from government, private industry, and academic institutions that are addressing utility infrastructure vulnerability due to climate change and could be used as resources by Con Edison and others interested in climate adaptation.

33. Does this conclude your pre-filed direct testimony?

33-A. Yes, it does.