Addressing Greenhouse Gases and Climate Change in NEPA Reviews As A Regulatory Agency

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The contemporary issues of greenhouse gas (GHG) emissions and climate change impacts have been receiving widespread attention over the last decade. For Federal agencies implementing the National Environmental Policy Act (NEPA)[i], these issues have caused consternation because there has been very little guidance as to how to address these issues within NEPA analyses. In the last few years, training courses have been established to assist agencies in addressing their GHG footprints and climate change impacts. However, there has been little opportunity for Federal agencies to learn from each other about this topic due to different regulatory authorities and the recent emergent nature of this issue in the NEPA landscape. Over the last few years, U.S. Nuclear Regulatory Commission (NRC) staff has worked to address the dual issues of accounting for GHG impacts from a proposed project and the impact of climate change on resources affected by the proposed project. This paper will discuss successes and difficulties encountered by the NRC staff when trying to address these topics in NEPA reviews, what has been gleaned from training courses, Council on Environmental Quality (CEQ) guidance, review of other Federal agency Environmental Impact Statements (EIS), and finally, the frameworks developed specifically to address these topics for new reactor construction and operational emissions.

The NRC conducts NEPA reviews for various actions, including licensing new nuclear reactors (construction permits and operating licenses under 10 CFR Part 50[ii]; combined licenses, early site permits, and limited work authorizations under 10 CFR Part 52[iii]), authorizing license renewals of existing reactors (10 CFR Part 54[iv]), and licensing fuel cycle facilities (such as uranium enrichment facilities; 10 CFR Parts 30[v], 40[vi], and 70[vii]). In 2009, two NRC Atomic Safety Licensing Boards referred rulings on GHG emissions and climate change to the Commission[viii]. The Atomic Safety Licensing Boards suggested that the Commission may want to consider the "… potential generic significance of the issue …" of GHG emissions and climate change. The Commission provided guidance to the staff on addressing GHG issues in environmental reviews in CLI-09-21[viii]. After this Commission direction, NRC staff began to formalize the approach to addressing these issues in environmental reviews under NEPA.

Guidance from CEQ[ix] directs agencies to consider GHG and climate change impacts in their environmental reviews. With the purpose of informing decision-making, CEQ proposes in its 2010 draft NEPA guidance[ix] on "Consideration of the Effects of Climate Change and Greenhouse Gas Emissions" that the NEPA process should incorporate consideration of both the impact of an agency action on the environment through the mechanism of GHG emissions and the impact of changing climate on that agency action. CEQ recommends that GHG emissions can be used as a "proxy" for assessing climate change impacts[ix]. After this guidance was issued, agencies began incorporating GHG emissions into their NEPA reviews but continue to struggle with addressing climate change impacts on a project's resources.

GHG IMPACTS FROM THE PROPOSED PROJECT

The Duke University course, Climate Change Under NEPA, and The Shipley Group course, NEPA Climate Change Analysis and Documentation, both discussed ways to address GHG emissions from a proposed project. Several methods were presented between the two courses. This material was used to inform the framework that NRC staff decided to develop to address the issue for construction and operation of new nuclear power plants. The NRC staff approach was also informed by the CEQ guidance[ix].

The NRC Staff considers the emission of CO_2 and other GHGs as an important air quality issue consistent with CEQ's guidance[ix]; i.e., "[T]his is not intended as a 'new' component of NEPA analysis, but rather as a potentially important factor to be considered within the existing NEPA framework." Consequently, discussions related to the consequences of CO_2 and other GHG emissions are included within the context of air quality issues in the EISs rather than in a separate section.

The NRC staff saw the need to address GHG emissions and decided to do so generically in such a way that the emissions could be scaled to the number of nuclear power plants being built. Efficiency is gained by creating the generic GHG footprint because it is created one time and then applied to all EIS for new reactor construction and operation. GHG emissions from various phases of construction and operation of a nuclear power plant should not differ significantly from site to site. This generic approach is similar to the approach the staff currently takes in addressing uranium fuel cycle impacts for each new nuclear power plant. As part of the NRC's regulations in 10 CFR 51.51[x], Table S-3, Table of Uranium Fuel Cycle Environmental Data, provides the NRC a framework for assessing the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power plant. This table is used to address impacts from the uranium fuel cycle as part of the proposed action in the EIS. The impacts in Table S-3x are for a generic 1000-MW(e) reactor and can be scaled to reactor size and number of units being built. The staff took a similar approach in creating the GHG footprint; the footprint was created for a generic 1000-MW(e) nuclear power plant and its resultant emissions could be scaled to reactor size.

URANIUM FUEL CYCLE

Table S-3 in 10 CFR 51.51x did not consider GHG emissions explicitly. However, the staff used the annual electrical energy and process heat needs and the amount of fossil fuels consumed to generate the necessary electrical power and process heat to estimate the annual GHG emissions associated with the uranium fuel cycle. According to Table S-3x, the annual fossil fuel use required to support the uranium fuel cycle for a reference 1000 MW(e) reactor includes 118,000 metric tons (MT) of coal to generate 323,000 MWh of electrical energy and 135,000,000 standard cubic feet (scf) of natural gas to generate process heat. The staff estimated the GHG emissions from these two fossil fuel sources to comprise the total GHG emission from the uranium fuel cycle for a nuclear power plant, 10,500,000 MT CO_2 equivalent.

CONSTRUCTION

The construction emissions were estimated based on estimates submitted by an applicant. Federal actions in nonattainment or maintenance areas designated under 40 CFR Part 81[xi] require a general conformity applicability analysis to determine whether emissions from the proposed action would conform to an applicable implementation plan. The General Conformity Rule (40 CFR Part 93, Subpart B[xii]) ensures that Federal actions do not interfere with a state's plans to bring an area into attainment with National Ambient Air Quality Standards or any applicable

State Implementation Plan or Tribal Implementation Plan. As part of a general air conformity review, an applicant submitted estimates of construction and operation emissions. After review and comparison with other submittals for similar projects, the estimate was found to be appropriately conservative and representative of building activities.

OPERATIONS

The main source of GHG emissions during operations are the diesel generators used for backup power at an operating nuclear power plant. The NRC staff estimated GHG emissions related to plant operations from typical usage of various diesel generators onsite, as obtained from several applicants for new nuclear power plants. The estimate included emissions from four emergency diesel generators and two station blackout diesel generators, both operating intermittently throughout the year[xiv].

DECOMMISSIONING

The estimate of decommissioning emissions posed a challenge for staff. A nuclear power plant decommissioning EIS hasn't been issued in over a decade, and at that time, GHG emissions weren't being addressed in EIS or reported by nuclear power plant licensees. The NRC staff developed a generic EIS for decommissioning, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1* (NUREG-0586)[xiii] in 2002, but that generic EIS doesn't quantitatively address air quality or GHG emissions. There is a lack of recent data for decommissioning U.S. nuclear power plants. Therefore, an estimate of decommissioning emissions of one half those of construction was used[xiv]. This value may be large for decommissioning however, the entire lifecycle footprint is dominated by uranium fuel cycle emissions and as such a change in decommissioning emissions would not greatly impact the overall lifecycle GHG emissions estimate.

The result of these four phases of a nuclear power plant lifecycle was a total GHG emission footprint of approximately 10,500,000 MT CO_2 equivalent for the reference 1000-MW(e) nuclear plant. This value can then be scaled to larger reactor sizes to come up with an appropriate GHG footprint for each proposed nuclear power plant EIS.

The GHG emissions footprint developed is considered by NRC staff as a conservative estimate of emissions for several reasons. As discussed in NRC's staff guidance to support Interim Staff Guidance-026 (ISG-026), *Staff Guidance for Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact Statements*[xiv], the largest use of electricity in the fuel cycle comes from the enrichment process. The development of Table S-3x assumed that the gaseous diffusion process is used to enrich uranium. Recent applications for new uranium enrichment facilities indicate that gas centrifuge and laser separation technologies are likely to eventually replace gaseous diffusion technology for uranium enrichment in the United States. The same amount of enrichment from gas centrifuge and laser separation facilities is likely to use significantly less electricity and therefore result in lower amounts of air emissions such as CO_2 than a gaseous diffusion facility. In addition, U.S. electric utilities have begun to switch from coal to cheaper, cleaner- burning natural gas, therefore the Table S-3 assumption that a 45-MW(e) coal-fired plant is used to generate the 323,000 MW-hour of annual electric energy for the uranium fuel cycle also results in conservative air emission estimates. Therefore, the values for electricity use and air emissions in Table S-3x continue to be appropriately bounding values for a new nuclear power plant.

As a way to benchmark the GHG footprint, the lifecycle value was compared to other available GHG footprints for nuclear power plants. The Intergovernmental Panel on Climate Change (IPCC) released a special report on renewable energy sources and climate change mitigation in 2012[xv]. The IPCC report includes an assessment of previously published works on lifecycle GHG emissions from various electric generation technologies, including nuclear energy. The IPCC-screened estimates of the lifecycle GHG emissions associated with nuclear energy, as shown in Table A.II.4 of the report[xv], ranged more than two orders of magnitude, from 1 to 220 grams (g) of CO_2 equivalent per kWh, with 25 percentile, 50 percentile, and 75 percentile values of 8 g CO_2eq/kWh, 16 g CO_2eq/kWh, and 45 g CO_2eq/kWh, respectively. The range of the IPCC estimates is due, in part, to assumptions regarding the type of enrichment technology employed, how the electricity used for enrichment is generated, the grade of mined uranium ore, the degree of processing and enrichment required, and the assumed operating lifetime of a nuclear power plant. The NRC staff's lifecycle GHG estimate of approximately 10,500,000 MT CO_2 eq for a 1000 MWe nuclear plant is equal to about 37.5 g CO_2eq/kWh, which falls between the 50 and 75 percentile values of the IPCC-screened estimates. The NRC staff found this reasonable.

The complete GHG lifecycle footprint was finalized and made public in September 2013. The NRC staff issued the ISG-026, *Staff Guidance for Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact Statements*[xiv], which contains the GHG footprint. The draft ISG-026 was released for public comment in September 2013 and will be finalized in 2014.

Because GHG emissions are not particularly sensitive to the location of the release point and are long lived and travel long distances, the impact from GHG emissions is global rather than local and should be viewed in a global context. From the CEQ guidance[ix]ix, "Because climate change is a global problem that results from global GHG emissions, there are more sources and actions emitting GHGs (in terms of both absolute numbers and types) than are typically encountered when evaluating the emissions of other pollutants…The global climate change problem is much more the result of numerous and varied sources, each of which might seem to make a relatively small addition to global atmospheric GHG concentrations. CEQ proposes to recommend that environmental documents reflect this global context…". However, it is difficult to put emissions into context when comparing a project's emissions to the global or even U.S. annual emissions because invariably a single project's emissions would be small. The Duke University Environmental Leadership course, Climate Change Under NEPA, suggests different ways to put emissions into context. The course material suggests comparing a project's emissions to those of the state where the action is proposed, or comparing emissions to the region. The NRC staff has considered these approaches and used them in recent EIS, and where data is available, staff has even compared project emissions to the subset of GHG emissions from energy production in the state where the proposed action is located. By putting these emissions into context, the public and decision makers can view the emissions from the proposed project alongside emissions for the area surrounding the project in order to determine the real impacts from the proposed project. Additionally, based on the information from the Duke University Environmental Leadership course, NRC new reactor EIS include a table of GHG emissions from various sources, including the proposed nuclear power plant, in order to put emissions into context for the reviewer. The following table is an example from a recent NRC EIS:

Source	Metric Tons per Year[(a)]
Global Emissions from Fossil Fuel Combustion (2010)	32,000,000,000
U.S. Emissions from Fossil Fuel Combustion (2011)	5,300,000,000
Pennsylvania Emissions from Power Production (2012)	107,000,000
1,000-MW(eq) Nuclear Power Plant (including fuel cycle, 80 percent capacity factor)	260,000
1,000-MW(e) Nuclear Power Plant (operations only)	4,500
Average U.S. Home	19
Average U.S. Passenger Vehicle	5

Note: 1 metric ton (MT) = 1.1 U.S. tons (at 2,000 lb per U.S. ton)

(a) Emission estimates from U.S. fossil fuel combustion, Pennsylvania power production, and nuclear power are in units of MT per year of CO_2 equivalent (eq) whereas the other energy emissions estimates are in units of MT per year of CO_2. If the emissions in units of MT per year of CO_2(eq) were represented in MT per year of CO_2, the value would be slightly less, as other GHG emissions would not be included.

After receiving public comments on several EIS regarding GHG emissions from various energy sources, the NRC staff has considered further approaches to putting emissions into context for the public. Recent NRC EIS for new reactor construction and operation now compare emissions from the proposed project (nuclear power plant) to those from competitive energy alternatives (coal and natural gas). Those competitive energy alternatives would be capable of providing baseload power, which is typically the purpose and need for the proposed project. An example of this comparison from a recent EIS is below:

Table 9-5. Comparison of Carbon Dioxide Emissions for Energy Alternatives

Generation Type	Years	CO_2 Emissions (metric tons)[a]
Nuclear Power[b]	40	362,000
Coal-Fired Generation[c]	40	556,000,000
Natural-Gas-Fired Generation[d]	40	255,000,000
Combination of Alternatives[e]	40	282,000,000

(a) Nuclear power emissions are in units of metric tons of CO_2 equivalent, whereas the other energy alternatives emissions estimates are in units of metric tons of CO_2. If nuclear power emissions were represented in metric tons of CO_2, the value would be slightly less, because the other greenhouse gas emissions would not be included.
(b) From Section 5.7.1.2 for two units operational emissions, not including CO_2 emissions for workforce transportation.
(c) From Section 9.2.3.1.
(d) From Section 9.2.3.2.
(e) From Section 9.2.4.

This table has proven useful in answering many questions from the public. The information from the Duke University Environmental Leadership course has proven helpful in shaping these methods of conveying GHG impacts from construction and operation of a nuclear power plant.

CLIMATE CHANGE IMPACTS ON THE PROPOSED PROJECT RESOURCES

It has been particularly difficult to address the second aspect of climate change in the CEQ[ix] memo, the impact of climate change on the project resources. There are very few examples of this in Federal agency EIS, and there is little guidance as to how to implement this. After considering information discussed in the Duke Environmental Leadership course and The Shipley Group course, the NRC staff has decided to address the impacts of climate change on the project by addressing the climate change impact on a particular resource and overlay those impacts with the project's impact on that resource. In this way, the dual impacts of the project and climate change on a resource are addressed. There has been much internal discussion as to how to portray climate change's impacts with the proposed project's impacts. For example, what if sea level will be rising at a project location, and therefore increasing the water availability in an area such that the impact of water withdrawal for power plant operation is actually less than it would have been without climate change-induced sea level rise? Does the environmental impact on water availability actually decrease due to climate change? How would we accurately represent these two dynamics in the EIS?

To develop an approach to address climate change impacts on a project's resources, the NRC staff began to look for examples of how climate change was addressed by other federal agencies. The EPA's EIS database allows review of Federal agency EIS that have been submitted to EPA in accordance with Section 309 of the Clean Air Act. Several examples from the U.S. Army Corps of Engineers (Corps) proved useful in shaping NRC staff guidance.

In the Central Everglades Planning Project (CEPP) EIS[xvi], the Corps addressed sea level rise (SLR) in an Appendix to the EIS. The Corps has separate guidance for 'evaluating the effects of sea level rise under multiple scenarios'[xvii]. The Corps planning guidance (EC 1165-2-211)[xvii] recommended an analysis of SLR at low, intermediate and high levels at 20, 50, and 100 years following the completion of project construction. In this CEPP EIS[xviii], the Corps discussed the historic SLR and then calculated future SLR for the low, intermediate and high scenarios at 5 year intervals per EC 1165-2-212 guidance[xvii]. Consistent with the CEQ guidance[ix], the EIS appendix contained an uncertainty discussion. The CEPP EIS says "*Scientific unknowns also present a significant source of uncertainty in the effects and timing of impacts from SLR. It is unclear how quickly and successfully natural area habitat and species can transition or adapt to the range of potential future conditions anticipated due to ongoing and accelerating global climate change. This analysis assumed that estuarine habitat quantity remained unchanged as sea level increases.*" In this way, the Corps acknowledges the uncertainty of SLR projections and acknowledges that it is unknown how resources could be affected due to this uncertainty. The Corps then makes an assumption regarding a particular resource for purposes of analysis in order to reveal the impacts of the proposed project along with SLR. The EIS appendix contains a conclusion that recaps the three SLR scenarios but does not choose a particular SLR scenario for the future. The Corps discusses the biggest uncertainties with the various projections. This EIS proved valuable in that it provided an example of the extent to which an agency must address the changing climate in an EIS. Agencies find it difficult to definitely state the likely outcome of climate change on a resource; this EIS avoids that issue by revealing several possible outcomes and addressing uncertainties of each outcome, consistent with CEQ guidance. From the CEQ guidance[ix]ix, "Where agencies consider climate change modeling to be applicable to their NEPA analysis, agencies should consider the uncertainties associated with long-term projections from global and regional climate change models. There are limitations and variability in the capacity of climate models to reliably project potential changes at the regional, local, or project level, so agencies should disclose these limitations in explaining the extent to which they rely on particular studies or projections."

In the Corps' Tarmac King Road Limestone Mine Final EIS[xviii], the Corps discussed SLR in the affected environment section, as was suggested in the Duke Environmental Leadership course, Climate Change Under NEPA, and in the article "*NEPA and Climate Change, Part 2: Ten Steps to Taking a Hard Look'*[xix] under Step 3, "Describe the existing global, regional, and applicable local context in which climate change impacts are occurring and are expected to continue. This discussion could occur in a separate climate change section of the document but would likely be more effective woven into the description of each resource being analyzed in detail in the NEPA document." In this EIS[xviii], the Corps continues to rely on its guidance[ix], and interestingly, suggests an adaptive management approach. An excerpt from the affected environment section of the EIS[xviii] states:

"The high degree of uncertainty in the sea-level change predictions is evident in the differences in projected shorelines for the low, intermediate, and high scenarios. This makes it problematic to incorporate the predictions into planning and/or configuration of the mitigation areas for the project. Relying on the worst-case predictions could be overly conservative and eliminate viable, valuable, and potentially long-lasting habitat improvements in the proposed mitigation area. Overlap of the predicted shoreline with the westernmost edge of the mitigation area is not predicted to occur under any of the sea level change scenarios until the 50-year project timeframe (for the high or worst-case scenario only in this timeframe). Additionally, the predicted shoreline would not overlap with the mitigation area boundary at all for the low sea-level rise scenario for any timeframe up to and including 100 years, and for the intermediate sea-level rise scenario would only result in slight overlap with the western boundary of the

mitigation area in the 100-year timeframe. ***This means that it would be suitable to consider an adaptive management approach to sequential implementation of the mitigation plan. Such an approach would consist of adjusting sea-level rise predictions through time based on the most current data and reevaluating the potential for impacts on the mitigation area****."[emphasis added]*

The mitigation chapter of the EIS[xviii] says "*The predicted sea-level rise would begin to encroach on the western part of the mitigation site in 25 to 50 years for the worst-case scenario. For the medium-case scenario, encroachment would not begin until sometime after 50 years but before 75 years. The predicted sea-level rise is an event influenced by factors unrelated to the proposed mining. In addition, the methodology for calculating the potential sea level rise is still in debate within the scientific community and published results vary widely. However, depending on the alternative selected and the length of any mining permit, if issued,* ***areas within the mitigation parcel that are expected to become inundated during the period evaluated for a permit would either be assessed for removal from the mitigation plan, have reduced mitigative value if included, or be otherwise addressed through special permit provisions imposed by the USACE****." [emphasis added]* The Corps' approach to adaptive management and mitigation are very different than those at NRC based on the different level of authority granted to each Agency per each Agency's implementing regulations.

This mitigation and adaptive management approach for impacts of climate change raised the question as to how NRC could implement adaptive management, NRC being an agency with limited regulatory authority regarding mitigation. These different levels of authority between agencies can be confusing to the public. In fact, as discussed in Climate Change Under NEPA: Avoiding Cursory Consideration of Greenhouse Gases[xx], it appears to the public that many agencies are doing the minimum work to meet NEPA obligations, and therefore are not discussing project alternatives to reduce GHG emissions or mitigation. Even though it may appear this way to the public, this is not always the case. As a regulatory agency, the issue of imposing mitigation on an applicant for environmental impacts has proved challenging for NRC. The NRC is a regulatory agency with oversight and licensing authority under the Atomic Energy Act of 1954[xxi]. The NRC does not have regulatory authority under the Atomic Energy Act[xxi] to determine where a facility should be built, but rather makes a determination on whether the proposed site is safe for construction and operation of a facility. Unlike other Federal agencies, the NRC cannot point an applicant to an alternative site and provide a license for that alternative location but can only approve or disapprove the applicant's request to build at the proposed site. In many cases, mitigation for environmental impacts cannot be imposed by NRC on an applicant unless the mitigation is required by another regulation that the NRC must follow, such as the Clean Air Act or the Endangered Species Act of 1973. Due to this limitation, NRC staff has ended the EIS discussion at revealing the impacts of the action, rather than requiring mitigation to reduce the impacts as other agencies may do, or for the case of SLR due to climate change, requiring an applicant to build a facility in a location less susceptible to SLR.

However, NRC does have authority to address issues for operating nuclear power plants through ongoing licensing design basis reviews under 10 CFR Part 50[ii]. As part of its oversight authority, the NRC can issue orders to licensees or develop new or amended regulations to address emerging issues that could impact the safety of a nuclear power plant. For instance, orders[xxii] were issued in response to the March 2011 earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant. In March 2012, the NRC issued a request for information[xxii] to all U.S. nuclear power plants asking licensees to (1) conduct visual inspections to identify and address plant-specific vulnerabilities and verify the adequacies of monitoring and maintenance procedures; and (2) reevaluate the flooding hazards at the plants against present-day NRC requirements and guidance to ensure that the plants are designed, operated, and maintained in such a manner that safety-significant structures, systems, and components are able to withstand the effects of floods. In addition to requiring licensees to reevaluate and upgrade as necessary the design basis flooding protection of systems, structures, and components important to safety, the NRC will use the information collected to determine whether further regulatory action is needed (e.g., confirm flooding hazards every 10 years; address any new and significant information; and, if necessary, update the design basis for systems, structures, and components important to safety).

Weighing information from the two Corps EIS discussed above, the CEQ guidance[ix], and the training courses, the NRC staff began to develop an approach to addressing impacts of climate change on project resources. In order to systematically address the impacts of climate change on a particular resource, the NRC staff has taken a more structured approach rather than simply directing authors to reference the latest U.S. Global Change Research Program (GCRP) report[xxiii]. The latter approach led to varying levels of discussion of climate change impacts depending on a section author. The structured approach the staff is currently developing allows authors to systematically review climate change indicators in the GCRP report[xxiii] to make sure climate change indicators on a resource were considered at a particular site. There is great uncertainty associated with climate change impacts, as discussed in the CEQ guidance[ix]ix; it is difficult to emphatically say that a certain changed climate scenario will be realized in the future. Because of this, staff thought it better to be broad in coverage but limited in depth. The structured approach involves regional impacts from the GCRP report[xxiii]xxiii overlaid with aspects of environmental review. The NRC's Environmental Standard Review Plan (ESRP)[xxiv]xxiv, NUREG-1555, that directs the staff's assessment of potential impacts of the proposed action on the environment. Each area of the environmental review is evaluated to determine if climate change indicators from the 2014 GCRP regional assessment would change the environmental impact on the resource from the proposed project. The areas of greatest concern for the proposed project would be the areas receiving the most attention from the structured approach analysis. This is consistent with CEQ guidance[ix]ix, "The focus of this analysis should be on the aspects of the environment that are affected by the proposed action and the significance of climate change for those aspects of the affected environment. Agencies should consider the specific effects of the proposed action (including the proposed action's effect on the vulnerability of affected ecosystems), the nexus of those effects with projected climate change effects on the same aspects of our environment, and the implications for the environment to adapt to the projected effects of climate change."

The staff created a large two-dimensional table by identifying plausible nexus among nuclear power station resource area issues relating to construction and operation as identified in NRC's ESRP (NUREG-1555)[xxiv] and likely climate change impacts as identified in the most recent impact report issued by the GCRP[xxiii]xxiii. For example, one climate change indicator in GCRP's 2014[xxiii]xxiii report is declining Arctic sea ice. Based on the location of proposed new nuclear power plants and operating nuclear power plants, declining Arctic sea ice should not definitively be linked to a change in the climate near a nuclear power plant. Therefore, that nexus point was removed from the overall table. Another climate change indicator, changing precipitation patterns, may have an impact on various resources affected by a new nuclear power plant, such as water availability or effluent releases to receiving bodies of water. This would be one nexus area that staff would then evaluate as part of the climate change analysis.

The comprehensive table was used to develop a list of questions for each resource area (land use, ecology, hydrology) to assist staff in addressing whether GCRP-identified climate change impacts were likely to increase, decrease, or leave unchanged the assessed impact of a proposed facility on the environment, or to identify areas where scientific uncertainty precludes a definitive assessment. If, at a particular site, the EIS reveals that water availability is being decreased by plant operation and causing a moderate impact, the staff then needs to ask how would a change in precipitation alter that finding? The GCRP report[xxiii] regional subsections are taken into account here for the area where the proposed project is located. Perhaps the projected climate change impact is that precipitation may be decreasing in the region where the proposed project is located causing periods of drought. How does the expected decrease in precipitation due to climate change alter the impact on water availability, as water availability is expected to decrease due to plant operation? Would the moderate impact become more significant once the climate change impact (decreased precipitation) is accounted for?

These nexus points and resultant questions would be answered by NRC staff in several sentences. The reasoning developed by the staff would then feed into a climate change appendix, organized by resource area (land use, ecology, hydrology), and each resource area would contain a summary conclusion at the end. The concluding statement would answer the question, "Does an altered baseline due to climate change affect the assessed impact of the plant on the environment?"

This approach will first be applied for a proposed nuclear power plant that is highly susceptible to the impacts of climate change due to it's location in southeast Florida, in Miami-Dade county. According to GCRP[xxiii]xxiii, global sea level is projected to rise 1 to 4 feet this century, and major cities like Miami are among those most at risk of flooding due to sea level rise.

Additionally, due to the different nature of licensing activities performed by NRC and the evolving topic of climate change, the staff has formed a GHG and climate change working group, thus allowing different offices within NRC to coordinate and maintain awareness of addressing these issues in environmental reviews.

The information gleaned from training courses through Duke University's Environmental Leadership program and from other agency EIS, along with the draft CEQ guidance[ix]ix, has proven invaluable in shaping NRC's current approach to addressing GHG and climate change for new reactor NEPA reviews. With the changing environment and expected revelation of new information in the future, the NRC staff is better prepared to adjust to changing guidance and regulations and new scientific developments due to the efforts undertaken to create this structured approach over the last several years. Collaboration with other Federal agencies would further enhance these efforts and optimally lead to a culture of information sharing on these evolving topics for those tasked with conducting NEPA reviews.

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[i] National Environmental Policy Act of 1969, as amended (NEPA). 42 U.S.C. 4321, *et seq*

[ii] 10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy,* Part 50, "Domestic Licensing of Production and Utilization Facilities."

[iii] 10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy,* Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

[iv] 10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

[v] 10 CFR Part 30. *Code of Federal Regulations*, Title 10, *Energy*, Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material."

[vi] 10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, "Domestic Licensing of Source Material."

[vii] 10 CFR Part 70. *Code of Federal Regulations*, Title 10, *Energy*, Part 70, "Domestic Licensing of Special Nuclear Material."

[viii] U.S. Nuclear Regulatory Commission (NRC). 2009: Memorandum and Order (CLI-09-21) In the Matter of Duke Energy Carolinas, LLC, and Tennessee Valley Authority. (Combined License Application for Williams States Lee III Nuclear Station, Units 1 and 2 and Bellefonte Nuclear Power Plant, Units 3 and 4), November 3, 2009. Docket Nos. 52-014-COL, 52-015-COL, 52-018-COL, 52-019-COL. Accession No. ML093070689.

[ix] Council on Environmental Quality (CEQ). 2010: 75 FR 8046. February 18, 2010. Memorandum for Heads of Federal Departments and Agencies. Subject: Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions. *Federal Register*. Council on Environmental Quality.

[x] 10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

[xi] 40 CFR Part 81. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

[xii] 40 CFR Part 93, Subpart B. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 93, "Determining Conformity of Federal Actions to State or Federal Implementation Plans", Subpart B, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans."

[xiii] NRC 2002: *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1.* NUREG-0586, Supplement 1, Washington, D.C.

[xiv] NRC 2013: *Attachment 1—Staff Guidance for Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact Statements*. COL/ESP-ISG-026, Washington, D.C. Accession No. ML12326A811.

[xv] Intergovernmental Panel on Climate Change (IPCC). 2012: *Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change.* Intergovernmental Panel on Climate Change. Cambridge University Press, 2012.

[xvi] USACE (U.S. Army Corps of Engineers). 2013. Draft Integrated Project Implementation Report and Environmental Impact Statement, Central Everglades Planning Project. August 2013.

[xvii] USACE (U.S. Army Corps of Engineers). 2011. Sea-Level Change Considerations For Civil Works Programs. Circular No. 1165-2-212. EC 1165-2-212.

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