**Appendix C: Comments and Responses to Emission Performance Standard CR102**

**Group 1 comments, January-February 2018**

**NRDC comment 1:** We understand that some form of filtering of purchases/sales has taken place to increase relevance to the Pacific NW. We would like to see the details of those purchases in order to be able to know if these are consistent with the objectives of the survey. Is there any reason why these cannot be listed publicly? In addition, if climate or other such inherent characteristics inherent to the Pacific NW may preclude some of those sales, it is not clear that the filtering has reflected such factors exclusively, or whether it reflects commercial practice or coincidence. We do not support weighting the survey based on current market choices only.

**Response:** The only Pacific NW data filtering done was to select advanced (J and H class) CCCTs of approximately 600 MW (next largest CCCT is 460 MW w/o duct firing) or less for the Emission Performance Standard (EPS) calculator. The 2012-17 US CCCT purchase data shows many large 2x1 and 3X1 format CCCT advanced J and H class (greater than 1000 MW capacity) were installed in electricity regions of the US that are dependent on large thermal generation resources. These large advanced power plants are often replacements for larger coal-fired or nuclear power plants. Since the Pacific NW is a hydro dominated electric power system it does not need, nor will it build, large CCCT power plants that contain multiple advanced gas combustion turbines. Consequently only 1X1 format advanced CCCT plants (still much larger than existing NW CCCTs) were included in the EPS calculator.

**Outcome:** No change to methodology

**NW Energy Coalition Comment 1:** We suggest removing F Class systems from the analysis. While a very small number of new sales have been concluded in recent years, the vast majority of the market is now for newer designs, generally in the G, H and J classes. The attached 2015 article from Power Engineering provides useful context.

**Response:** Refer to the 2012-17 U.S. CCCT installation summary table 1, which can also be found in the EPS calculator. The table reveals that the majority of purchases/installations, 70% of the total, were F or G class based systems. Note that the Mitsubishi G class heat rate is equivalent to the F class CCCTs offered by General Electric and Siemens, and therefore has similar emission characteristics: see reported heat rates and efficiency values for F versus G designated CCCTs in the EPS calculator. Over the last decade the four completed CCCT installations in the Pacific Northwest have been of the F and G class. They will probably continue to purchase intermediate F and G class CCCTs rather than the larger and more expensive H and J class units.

**Outcome:** No change to methodology

**NW Energy Coalition Comments 2**: We think, on balance, that duct firing should not be included in the analysis. While some CCCT systems are configured with duct firing, not all are. It is not statutorily required to include duct firing in the assessment, it is inherently inefficient in operation, and indeed is clearly aimed at a peaking mode of operation.

**Response:** The topic of duct firing was extensively discussed by stakeholders during the 2012-13 stakeholder process and rulemaking. Most of the Pacific Northwest CCCTs, including the recent built Carty plant in Oregon, have duct firing, so it is reasonable to include this attribute when developing the standard. In addition, the extra emissions from duct firing cannot be separated from overall emission rate (lb. CO2/MWh) of a regulated CCCT. Finally, during 2012 rulemaking cycle there was an expressed desire by the regulating agencies[[1]](#footnote-1) to have a single EPS value and not create 2, 3 or more niche EPS values for different CCCT configurations (i.e. with or without duct firing) or design/operating criteria (i.e. small vs. large CCCTs, high vs. low altitude, air vs. water-cooled cooled, etc.). See also the Commerce responses to very similar comments during the 2012 rulemaking cycle.

**Outcome:** No change to methodology

**NW Energy Coalition Comment 3:** It would be helpful to get a more complete list of recent CCCT purchases including approximate sale dates and purchasers. Of course, details may not be readily available in all cases, but given recent incremental changes in CCCT technology it may be useful to investigate further, particularly for the last 5 years.

**Response:** We included a detailed summary of the 2012-17 U.S. CCCT purchases in the EPS calculator. The summary table lists sales by manufacturer and CCCT type (aero, intermediate, and advanced).

**Outcome**: Location of additional information noted

**NW Energy Coalition Comment 4:** RCW 80.80.050 makes reference to CCCTs that are "commercially available and offered for sale by manufacturers and purchased in the United States," and does not separate out those deployed in the state of Washington or the Pacific Northwest. While minor variations may occur in system efficiency at specific sites (for example, due to elevation), we believe the full national market provides the best aggregate view of "the average rate of emissions of greenhouse gases for these turbines."

**Response:** We have not biased the representative mix of CCCTs selected for the EPS calculator towards PNW purchases. Refer to the summary 2012-17 U.S. CCCT purchase table. The mix of CCCTs in the EPS calculator is a very close match to the reported national survey CCCTs shown in the summary table: compare the manufacturer shares and as well as the small, intermediate and advanced CCCT model shares for the national survey with same parameters in the EPS calculator.

**Outcome:** Clarification

**Dept. of Ecology Comment 1:**

Dept. of Ecology prefers the “Alternative Version of Draft Rule, with Informational Table” which allows adoption by reference of the new emissions performance standard into Chapter 173-407 WAC.

Ecology also suggests to revise the table in WAC 194-26-020 (2) in the alternative version as follows:

|  |  |  |
| --- | --- | --- |
| **Average available greenhouse gas emissions output (lb. GHG/MWh)** | **Effective Date Range** | |
| **Start Date** | **End Date** |
| 970 | 4/6/13 | The day before the effective date of this section |

**Response:**

The term “superseded by rule” may cause confusion that the older standards are no longer in place, which is not the case.

When Commerce updates the emissions performance standard again in five years, the 930 lb. GHG/MWh will be added in this table as follows:

|  |  |  |
| --- | --- | --- |
| **Average available greenhouse gas emissions output (lb. GHG/MWh)** | **Effective Date Range** | |
| **Start Date** | **End Date** |
| 970 | 4/6/13 | x/x/18 |
| 930 | x/x/18 | x/x/23 |

**Response:** Comment acknowledged, will modify the proposed table.

**Group 2 comments: June 2018**

**NSN[[2]](#footnote-2) Comment** 1: Unfortunately, the current draft survey suffers from many of the same problems as the prior survey. The survey continues to exclude many modern, state of the art combined cycle combustion turbine (“CCCT”) units that have much lower GHG emissions rates. Instead, the survey again includes many older and inefficient models, and it weights the representation of those models so that smaller units skew the average results to a higher EPS standard. The result is a survey not of the newest and cleanest units available for purchase in the U.S., but instead a limited subset of units with lackluster performance criteria.

**Response**: The 2017 CCCT survey is an evolution of the 2012 EPS rulemaking cycle survey, and is described in the **EPS** **Overview** document. The national survey approach is derived from the following text in RCW 80.80.050: "a survey of new combined-cycle natural gas thermal electric generation turbines commercially available and offered for sale by manufacturers and purchased in the United States." In 2012, most stakeholders agreed that the key words in the above text were “commercially available” and “purchased in the United States”. Commerce interprets the language to mean that it is to base the survey on commercially available CCCTs that have been recently purchased and installed in the United States. The survey represents the types of new CCCTs that utilities are installing.

The language in RCW 80.80.050 does not require Commerce to specifically focus on just the newest, cleanest and largest CCCT designs for its survey and eventual inclusion in the EPS calculator. For this reason the 2017 survey excludes CCCTs that were not yet commercially available or installed – manufacturers typically announce and take orders for new CCCT designs several years before they are first installed. Often utilities make a down payment on a CCCT to hold a place in the production line. Both the 2012 and 2017 surveys were based on CCCTs that were purchased and had been or were being installed in the United States during the preceding 5 years. For the 2017 cycle we grouped the survey results more precisely by manufacturer and model category (small/aero-derivative, medium/established technology, large/advanced technology). The results of the 2017 CCCT survey represent CCCTs purchased in the United States from 2012 through mid-2017 and are presented in table 1 below, which can also be found in the EPS calculator document.

Table 1: National Purchase and Installation of CCCTs 2012-17



We used the manufacturer market and model category percentages from the survey, to determine the number of specific models of CCCTs to be included in the 2017 EPS calculator. We closely approximated the characteristics of the national survey set of 77 CCCTs with a representative subset of 20 CCCT models in the EPS calculator. These representative CCCTs and their associated Gas Turbine World derived heat and efficiency rates are then incorporated into the EPS calculator. The EPS calculator applies a series of heat rate adjustments to mimic challenging real world operating conditions and produces the draft EPS value that was presented in the CR 102 document.

**Outcome**: We maintain that the national survey methodology is both true to the language in RCW 80.80.050, and a rational way to populate the EPS calculator and determine the EPS value. No significant change to the methodology.

**NSN Comment 2**: The current survey backtracks from the 2012 survey by re-introducing models that date as far back as 1979 (GE F.03). Similarly, six of the eight Siemens units included in the survey have a 1989 design year. Of all the models included in the survey, only two designs are within the last five years (GE HA.02 and GE LM2500).

**Response**: As noted in the response to NSM comment 1 above, the manufacturer design date typically precedes commercial availability and installation dates by several years. As an example the Mitsubishi advanced J class CCCT has a design date of 2011 but was not installed during the previous EPS rulemaking cycle, which used a survey time window of 2007-12. Our current survey shows a J class machine first being installed in 2014. The Siemens H class CCCT has a design date of 2010 and was being installed towards the end of the 2007-12 survey window and was included in the 2012 EPS rulemaking.

In addition, CCCT manufacturers periodically update existing models, improving their efficiency and output, so design date typically does not represent the current performance level of a CCCT. The GE F.03 is an older CCCT design that has been updated several times since it became commercially available. Eleven GE F.03, two F.04 and twelve F.05 CCCTs were purchased/installed during the 2012-17 survey period, making it the second most common CCCT choice for utilities. The February draft survey and EPS calculator significantly over represented the GE F.04 model CCCT and underrepresented the F.03 model CCCT.

**Outcome**: To more accurately represent the 2012-17 national CCCT survey we will increase the number of GE F.03 CCCTs in the EPS calculator to two and reduce the number of F.04 CCCTs to one unit.

**NSN Comment 3**: First, removing the largest units removes the most efficient units. Sierra Club and NRDC’s comments from 2012 noted that several larger and more efficient units were available for purchase that had not been included in the 2012 survey. Commerce responded in response to comments #SV-15: “The rule that Commerce applied is that to be included in the Survey a CCCT had to be listed in the GTW Handbook and had to have been purchased by a utility and be either installed or in the process of being installed in the U.S. during 2007 – 12 (July 2012).”

Today, Commerce appears to be deviating from their own rule in order to yet again avoid including larger and more efficient turbines. There is no reasonable justification for such exclusions.

Second, Commerce apparently decided to duplicate mid-range turbine models. Most of this duplication appears to be the 1989 Siemens F model. This model has only a mid-range efficiency compared to newer and larger turbines. Duplicating that model therefore skews the results to maintain the status quo rather than update the standard to reflect the improvements in technology.

**Response**:

For the draft EPS we made the choice to use the 1 X 1 format for advanced H and J class CCCTs for the following reasons:

* The Northwest has not installed many large multi-combustion turbine CCCTs (Grays Harbor Energy Center, 620 MW, is the only example). The nameplate capacity of CCCTs in Washington averages about 300 MW, while the advanced H and J class machines in 2 X 1 or 3 X 1 formats range in size from 870 to nearly 1680 MW in size (this is before the duct firing increment is added in the EPS calculator). The 1 X 1 format H and J class CCCTs range in size from 460 to 560 MW of capacity (numbers do not include duct firing capacity), well above the Washington existing CCCT capacity average, but still a feasible size for a CCCT installation in the Northwest based on utility needs and finances.
* The EPS calculator approximates 2012-2017 contains specifications for 20 CCCTs, 4 of which were advanced H and J class types. There simply aren’t enough advanced model spots in the calculator to accept all of the possible H and J class CCCT formats. Since the 1 X 1 is by far the most likely Northwest format and for this reason it was selected for inclusion in the EPS calculator.
* Examination will show that the performance difference between the 1 X 1 and the 2 X 1 advanced CCCTs formats is very small; for the Mitsubishi J class machine the difference between a 1 X 1 and 2 X 1 format is about 0.2% when expressed on an efficiency basis (61.5% versus 61.7%). The 3 X 1 format was not listed in Gas Turbine World.

In conclusion, we selected the 1 X 1 format H and J class CCCTs for inclusion in the EPS calculator because the unit size better matches CCCT purchase patterns in the Northwest and because the performance difference between 1 X 1 and 2 X 1 formats is minimal.

Responding to the second part of the statement above regarding duplicate F class CCCTs. As described in the previous response, we chose to closely approximate the national survey installation patterns in the EPS calculator by using a smaller representative set of 20 CCCTs. The mid-sized and established technology F and G class CCCTs make up 70% of the installations in the national survey and accordingly are 70% of the entries in the EPS calculator: see Table 3 below. Because the F and G class machines are by far the most frequently installed CCCTs the EPS calculator, in order to approximate US market installations, must contain duplicates (2 to 5) of the GE and Siemens F class models, and the Mitsubishi G class model.

Table 3: CCCT Class and Manufacturer Count and Percentages in the EPS Calculator

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Class of CCCT** | **count** | **percent** |  | **Manufacturer** | **EPS count** |
| Aero/small | 2 | 11.1% |  | General Electric | 7 |
| Mid F/G | 12 | 66.7% |  | Siemens | 7 |
| Adv H/J | 4 | 22.2% |  | Mitsubishi | 4 |
| **Total** | **18** | **100%** |  | **Total** | **18** |



**Outcome:** Current approach is representative of purchases and installations. No change in methodology.

**NSN Comment 4**: Sierra Club, NRDC and NWEC are also concerned about the inclusion of aero-derivative turbines in the survey. Aero-derivative units tend to be small, relatively inefficient, and are rarely employed for baseload applications.

**Response:** Eight aero-derivative CCCTs were present in the national CCCT survey, representing slightly more than 10% of the CCCTs purchased/installed during the 2012-17 time window. A ninth aero-derivative CCCT was tentatively identified but could not be confirmed. Two aero-derivative CCCTs were included in the EPS calculator representing a 10% share for this class of CCCT.

Because we base our analysis on the national CCCT survey, Commerce believes that we cannot selectively exclude one particular class, or over represent another class of CCCT. Until recently the Northwest had an aero-derivative CCCT that was permitted as a baseload power plant (Big Hannaford near Centralia). The plant was not operated as a baseload plant but was permitted as one. The Encogen facility is a baseload permitted power plant (also not operated as one) utilizing three small frame 6 combustion turbines and is similar in size, though less flexible or efficient, than similar sized modern aero-derivative CCCTs.

Aero-derivative CCCTs offer several advantages over larger machines. They are less expensive and they are operationally more flexible. Their flexibility allows the Aero-derivative CCCTs to ramp up or down quickly, making them useful as for integrating variable resources such as wind and solar power or as a load following or seasonal power plant.

**Outcome:** We did not have detailed information on the aero derivative CCCTs installed during the 2012-17 timeframe. We altered the GE aero-derivative CCCT to a larger more efficient model, the LM6000, which could feasibly replace a smaller and older existing Northwest CCCT and be permitted as a baseload power plant. We will then recalculate the EPS value.

**NSN Comment 5**: Utilities would not purchase or install aero-derivative CCCTs because their emission rates are above the current EPS (paraphrasing).

**Response:** As noted in the NSN comment 4 responses above, Commerce populated the EPS calculator using the results of the representative national CCCT survey, which is guided by the “commercially available” and “purchased in the United States” language in RCW 80.80.050. We do not exclude CCCTs from the national survey because of we think utilities shouldn’t purchase them. Note, that because of the prospect of lower future EPS values utilities would certainly be wise to purchase the more efficient CCCTs presented in the national survey and the EPS calculator.

**Outcome:** No change to the methodology.

**NSN Comment 6**: Similarly, the survey duplicates many older units while excluding newer units. This means that a single 1989 turbine model (Siemens F model) is weighted six times more heavily than the newest and most efficient model in the survey, the GE HA.02. It is unclear why Commerce made this choice. The goal appears to be an attempt to maintain the same proportion of manufacturer’s market share in the U.S. as in the limited subset of survey results.

**Response:** Similar to the response for comment NSN 3, based on the national survey the mid-sized and established technology F and G class CCCTs make up 70% of the installations in the national survey. Accordingly the F and G class CCCTs make up 70% of the entries in the EPS calculator to mimic the national purchase\installation pattern. Two of the GE F class (F.04 and F.05) CCCT models have design dates of 2009, while the Mitsubishi GAC class CCCT has a design date of 2011. While the H and J class CCCTs are slightly newer the GE and Mitsubishi F and G class CCCTs should not be considered older units as mentioned in the comment above.

**Outcome:** No change to the methodology.

**NSN Comment 7**: In the EPS Calculator Spreadsheet under the “Ref” tab, line 12, Commerce notes that it included a 15% duct firing capacity assumption. However, in that same tab at the bottom of the sheet, Commerce includes a 2012 table showing that across all turbines in Washington, duct firing occurred only 10.7% of the time. Commerce increased that number first by excluding the plants without duct firing, and then rounding up. Finally, that inflated number was applied to ALL turbines in the survey. This adjustment is not reasonable. First, Commerce should revisit its estimates regarding duct firing with updated data. The 2012 data is stale. Second, even for units that use duct firing, the practice is generally limited and generally does not occur more than 15% of the time.

**Response:** The commenter above references 10.7 and 15% of duct firing time. We believe that they were referring to duct firing capacity and not time. During the 2012 EPS rulemaking and stakeholder meetings there was discussion around determining EPS values for several CCCT configurations: with and without duct firing, small vs. large CCCTs, new versus old, high altitude and location parameters, etc. The two entities responsible for enforcing RCW 80.80, Dept. of Ecology and EFSEC, strongly recommended that there be only one EPS value. This necessitates that all of the design, operational and locational parameters that impact CCCT fuel consumption, and consequently the emission factor calculations, have to be included in the calculations when establishing the EPS value. Existing Northwest CCCTs have an average duct firing capacity of 14.3%. As in 2012, Commerce chose to use the slightly conservative duct firing capacity value of 15% in the EPS calculator.

**Outcome:** Commerce will review and update, if necessary, the duct firing data during the next rule-making cycle.

**NSN Comment 8**: Even more appropriate would be to either eliminate the duct firing adjustment altogether, or at least re-review the information available in the last five years on duct firing. As Sierra Club and NRDC noted five years ago, the development of newer technologies even then had reduced reliance on duct firing.

**Response:** During the much larger 2012 EPS stakeholder process, duct firing was identified as a key performance parameter to be included in establishing the EPS value. It remains so during the 2017-18 cycle.

We interpret that the commenter believes that the Washington EPS applies only to future CCCT installations and that duct firing should not be included because future CCCTs are less likely to incorporated duct firing. This is inaccurate. RCW 80.80 reveals that in addition to applying to new CCCTs, the EPS applies to sales and purchases of existing CCCTs - power plants that frequently have duct firing. In addition, the EPS applies to contracts that Washington utilities establish with existing CCCTs.

Note that the last new CCCT in Washington came on line in 2008, however its construction began in 2001 and the initial permitting dates back to the 1990’s. There have been no new CCCTs constructed in Washington since then, and only three in the entire Northwest, all of which were F and G class CCCTs having some duct firing incorporated into their design. The recent application of RCW 80.80 has been primarily towards existing CCCTs.

**Outcome:** No change to the methodology.

**NSN Comment 9**. It also appears that Commerce did not determine the amount of duct firing that occurred, but rather developed a single duct firing correction factor that assumed that 100% of duct firing capacity was employed at all times when any duct firing was employed. This adjustment is unreasonable. In line 16 of the Ref tab, Commerce itself acknowledges that duct firing input varies from 0 to 100%, and “Eighty percent is likely on the high end.” Nevertheless, Commerce ignored its own information and applied 100% duct firing to all units at a 15% capacity factor.

**Response:** Commerce was responding to a specific stakeholder recommendation when the duct firing fuel input rate was set to 100% for the 2017 rulemaking. Several other input parameters used in the duct firing calculation were reduced during the 2017 rulemaking, the net result being that duct firing now makes a smaller contribution to the final adjusted emission rate for the CCCTs in the EPS calculator than in the 2012 cycle.

**Outcome:** The increase in the duct firing rate change was discussed at a stakeholder meeting but needs further review. We will return the duct firing fuel input rate to 80% and recalculate the EPS value.

**NSN Comment 10**: After establishing the higher heat value for each turbine in the survey, Commerce then applies a total 22.5% adjustment to account for various factors that it claims are necessary to account for variation in efficiency. We discussed above the problems with the duct firing adjustment. However, all of the adjustments are problematic because they are too high.

**Response:** There are two reasons for the large adjustment factor that is applied to the clean and new heat rate. First, during the 2012 rulemaking several stakeholders requested that Commerce determine a single EPS value. This means all the adjustment factors are applied to each CCCT model in the EPS calculator. Second, Commerce staff were convinced by arguments made by stakeholders that the survey (and EPS calculator) should not use average adjustment factors, but rather should use values towards the high ends of their distributions. Since RCW 80.80 compliance is evaluated on an annual basis, for new and older CCCTs, this protects utilities and plant operators from intermittent non-compliance due to being in the later years in a plant life and/or maintenance cycle, or challenging operating situations related to weather or market conditions. The 2017 heat rate adjustment factor is 21%.

**Outcome:** No change to the methodology other than noted in response to NSN comment 9. Commerce will review adjustment factors in the next EPS rulemaking.

**NSN Comment 11**: Commerce need not rely on these theoretical adjustment assumptions. Rather, Commerce should review the actual performance data available over the past five years from the turbines included in the 2012 survey and compare that performance to the theoretical efficiency from those units. That historical comparison will provide a far more accurate assessment of whether the 22.5% adjustment is reasonable.

**Response:** A very similar comment was presented by the same entities during the 2012 rulemaking process. See 2012 Concise Explanatory Statement Attachment 1, SV-31 for the Commerce response.

Commerce does not believe that using five year historical performance for existing CCCTs is an appropriate way to establish the adjustment factor: going from a "clean and new" to an operational emission rate for several reasons. First, some of the existing CCCTs could be early or midway between major maintenance services and could experience further degradation over the next several years. Weather, market conditions or other unforeseen factors could degrade future CCCT performance relative to the five year historical window. In addition, a minority of the existing CCCTs do not have duct firing, which tends to decrease the apparent adjustment factor between clean and new and reported emissions. For reasons presented above and during the 2012 rulemaking cycle, Commerce believes all of the heat rate adjustment factors have to be applied to each representative CCCT in the EPS calculator.

**Outcome:** No change to the methodology. See next section “Adjustments to the CR102” for the updated heat rate adjustment factor.

**NSN Comment 12**: Washington should not accommodate the perpetuation and development of inefficient gas plants. Such action is particularly troubling given the current position by the Trump Administration to abdicate all responsibility to address climate change concerns. If states like Washington do not drive responsible change to our electric sector, who will? The minimum we can ask from the State of Washington is to set an EPS that accurately reflects the advancements in gas turbine efficiency that is readily available in the marketplace, true to the spirit and letter of the state statutes that govern the EPS. The draft survey does not do that.

**Response:** As of 2018, four states—California, New York, Oregon, and Washington—have enacted mandatory GHG emissions standards (the EPS) that impose enforceable emissions limits on new and/or expanded (greater fuel input) electric generating units. Three states—California, Oregon, and Washington—have enacted mandatory GHG emissions performance standards that set an emissions rate for electricity purchased (contract power) by electric utilities. The Oregon and California EPS values remain at 1,100 lb./MWh, while the New York EPS is 925 lb./MWh but only applies to new CCCTs[[3]](#footnote-3).

**Outcome:** We note that after making the suggested methodology changes in response to comments 2, 4 and 9 the Washington EPS is recalculated to be 925 lb./MWh: see main document for details. The new Washington standard is equivalent to the New York state EPS, which only applies to new CCCTs. Because the Washington EPS applies to new and existing CCCTS as well as long-term utility contracts from existing CCCTS, it is arguably the most aggressive EPS in the nation.

1. Dept. of Ecology and EFSEC/UTC [↑](#footnote-ref-1)
2. NSN denotes NRDC, Sierra Club and Northwest Energy Coalition [↑](#footnote-ref-2)
3. New York is in the process of adding an EPS for existing baseload power plants. It is anticipated to be significantly higher than the 925 lb./MWh EPS established for new power plants. [↑](#footnote-ref-3)