

ERTAC EGU GROWTH IMPLEMENTATION SUBGROUP
Narrative Outline of Decisions and Rules for the Model

I. Definitions

- A. Power Pool – the smallest region used to dispatch generation in the model. This may be equivalent to a NERC Region, ISO/RTO Region or other logical dispatch area.
- B. Growth Pool – the generation needs above the base inventory based on projected growth over the base period and the generation supplied by any units retired between the base period and the projection year.
- C. Base Inventory – The normalized hourly inventory used for the base case modeling. This inventory is generally adjusted to remove all but consistent annual outage events on a unit. The data required includes emissions, hourly generation, and hourly heat input.
- D. Spinning Reserve – The minimum reserve required is equal to the maximum single contingency or 6% of the combined load and generation in the power pool. For purposes of this exercise it shall be defined as 100% of the largest unit of any type in the power pool being modeled.
- E. Excess Generation Pool – The accumulation of the generation in excess of the capacity of the units of a given fuel/unit type in a power pool. This generation will preferentially be allocated to units with remaining capacity in the power pool of origin, but it may also be allocated to units in adjacent power pools if generating and transmission capacity is available. The algorithm may not initially have the capability to allocate power from more than one region to the same unit. That feature may be added later in the process of development.
- F. Anomalous Units – Those units that are off line or operating at a very low capacity when normally that unit would be on line and operating at a significantly higher capacity. Examples of anomalous units are an unforeseen shutdown of a unit due to malfunction or a unit that is dispatched in a fashion that is unusual during the base inventory period.

II. Growth Implementation

- A. Units will only be retired through a manual process led by the State in which the unit being retired is located. Generation attributed to retired capacity will be added to the growth pool for the given fuel type in the power pool for dispatching over the generating fleet in the projection year.
- B. Overall generation for a region will generally be dispatched with renewables and nuclear units first, then coal, gas, and oil units depending on the relative fuel costs between coal, gas, and oil. This model will not deal with renewables and nuclear units explicitly. Changes in generation from these sources will impact generation predictions in coal, gas, and oil.
- C. This methodology will also implicitly include in the dispatch order power pool interchanges that may not be easily predictable on an hour to hour basis. It will be permissible to have a generating unit in one power pool dispatched by another pool if a long term agreement is in place and properly documented by either the

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State receiving the energy or the State hosting the unit. This may be a functionality that is added after the algorithm is initially developed.

D. Unit Dispatch Order Issues

1. The base year CAMD data will be used to determine unit dispatch order.
2. Use of actual load data in determining dispatch order implicitly sets the cost relationship between the fuels (coal-gas-oil-nuclear-renewable) based on the base year relationships. Changes in the future are implicitly included by changes in the growth factors in the power pool.
3. The utilization fraction as calculated from the base year data will be used to determine dispatch order for units that were operating in the base year. Utilization fraction is the ratio of the total average heat input to the maximum heat input for a unit: $\text{total average annual heat input}/(\text{maximum hourly rated capacity} * 8,760 \text{ hours/year})$.

E. Hourly Hierarchy Issues

1. Base year CAMD load data will be used to determine the hourly, 6-hour block, or daily hierarchy for power distribution.
2. For all fuel/unit types except coal and gas-combined cycle, the model will be dispatched on an hour-by-hour basis starting with the peak hour in the base year and going to the hour with the lowest generation.
3. For coal, the model will dispatch the day with the highest hourly generation first. The model will dispatch the hours in that day from 0 to 23, in that order. The next day to be dispatched will be the day with the highest hourly generation and where that hour has not yet been allotted generation. This methodology is used to prevent coal fired units from being frequently turned on and off.
4. For gas-combined cycle, the model will dispatch the 6-hour block with the highest hourly generation first. The model will dispatch the hours in that block from 0 to 5, in that order. The next block to be dispatched will be the block with the next highest hourly generation and where that hour has not yet been allotted generation. In this methodology, each day is divided into four blocks of 6 hours: 0-5, 6-11, 12-17, 18-23. This methodology is to prevent natural gas-combined cycle units from being frequently turned on and off.
5. Input variables may be set up to allow any of the three hourly hierarchy methods (hourly, 6-hour block, or 24-hour block) to be applied to any ERTAC fuel/unit type bin.
6. By establishing the dispatch order on a per hour, a per 6-hour block, or per day basis, the entire fleet will be grown in a more representative fashion, including the “anomalous units”.

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7. Future year new units
 - a) Future year new units will be added primarily by a manual process led by the State in which the unit is situated.
 - b) Future year new units will be added by ERTAC fuel/unit type bin and will be assumed to be proxy loaded for the start of the first year of operation by assigning generation to the new unit from the overall pool and inserting the new unit into the inventory as follows:
 - (1) New coal fired units (includes IGCC)
 - (a) The proxy loading for these units will be equivalent to a 50% load factor (50% of maximum rated capacity) for hourly operations. This represents the unit being inserted into the dispatch order at a nominal minimum load rate and then absorbing growth and additional generation from the excess generation pool up to its full load rating.
 - (b) New coal fired units will be inserted into the coal fired dispatch order directly behind the unit representing 5% of the coal fired units in the power pool. IGCC units will be inserted into the inventory after the unit representing 2% of coal fired units' power pool.
 - (c) The max ERTAC annual utilization fraction for that ERTAC fuel/unit type bin will be applied.
 - (2) Gas Combined Cycle
 - (a) The initial hourly percent load profile for a new unit shall match that of the GCC unit immediately beneath the unit in the dispatch order prior to the application of that year's growth.
 - (b) New units will be added to the dispatch order after the unit representing 5% of the GCC fired units in the power pool unless otherwise specified by State staff.
 - (c) The max ERTAC annual utilization fraction for that ERTAC fuel/unit type bin will be applied.
 - (3) Simple Cycle Gas and Boilers
 - (a) Initial hourly percent load profile for a new unit shall match that of the simple cycle gas unit or

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- boiler immediately beneath the unit in the dispatch order prior to the application of that year's growth.
 - (b) New units will be added after the unit representing 2% of the simple cycle gas units or boilers in the power pool, unless otherwise specified by State staff.
 - (c) The max ERTAC annual utilization fraction for that ERTAC fuel/unit type bin will be applied.
 - (4) Oil Units
 - (a) Initial hourly percent load profile for a new unit shall match that of the oil unit immediately beneath the unit in the dispatch order prior to the application of that year's growth.
 - (b) New units will be added after the unit representing 2% of the diesel units in the power pool, unless otherwise specified by State staff.
 - (c) The max ERTAC annual utilization fraction for that ERTAC fuel/unit type bin will be applied.
 - (5) The new unit defaults listed above for each ERTAC region and ERTAC fuel/unit type bin may be modified in the Input Variables worksheet.
 - c) Unit optimal load thresholds for new units will match the percentage unit optimal load threshold for the existing unit immediately beneath the new unit in the dispatch order.
- F. General Growth Methodology
1. After new units receive proxy loadings, the remaining growth within an ERTAC fuel/unit type bin will be allocated uniformly across the units of that ERTAC fuel/unit type bin in the ERTAC region.
 2. Next, a comparison with the maximum capability will be done on a unit by unit basis starting with the first unit in the dispatch order to determine if the unit has been grown beyond its maximum capacity.
 3. If a unit has been grown beyond its maximum capacity on an hourly basis or annual basis, the excess shall be removed and pooled in an excess generation pool.
 4. Each hour of the year shall be processed as noted above prior to allocating generation from the excess generation pool to the units in the ERTAC fuel/unit type bin and ERTAC region.
 5. Emptying the excess generation pool:
 - a) Power in the excess generation pool will be distributed in two passes. The first pass will add generation to a unit up to the unit's

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- maximum optimal load threshold. Maximum optimal load threshold is calculated by a percentile of the unit's hourly base year data. The current default for this is the 90th percentile. This is a variable that may be adjusted in the Input Variables spreadsheet.
- b) During the first pass, some units may already be at or near their maximum rated capacity due to the uniform distribution of growth. These units will not have generation removed. However, since they are already estimated to operate at levels above the unit maximum optimal load threshold, they will not receive additional generation during the first pass.
 - c) If the excess generation pool has not been emptied after all units have been elevated to their unit maximum optimal load threshold, a second pass through the unit hierarchy will be performed, where generation will be allotted up to each unit's maximum capacity (either on an hourly or an annual basis).
 - d) Maximum hourly capacity utilization shall be no greater than 100% of unit capability.
 - e) Max annual ERTAC utilization fractions shall be no greater than 0.90 for coal units, 0.60 for gas combined cycle, and 0.18 for simple cycle gas and oil units. Base year utilization is calculated, and a unit's max_annual_ERTAC_utilization_fraction that is larger than these defaults will be used in place of these defaults. These defaults may be adjusted in the Input Variables spreadsheet.
 - f) Units in the future year that have power generation constraints significantly different than those in the base year may have a "Y" in the "Capacity-Limited Unit Flag" field. For these units, rather than comparing the annual utilization to the max_annual_ERTAC_utilization_fraction, the annual utilization should be compared to the data in the "Unit Annual Capacity Limit" field.
 - g) In the event that a given fuel type cannot absorb the growth assigned to it in a given year and that growth cannot be covered by shifting the excess to an adjacent power pool, a flag shall be thrown indicating that additional generation resources of the ERTAC fuel/unit type bin are required to meet the growth requirements of the power pool.
 - h) In the event that the total needed capacity in a power pool exceeds the total installed capacity of all types minus the mandatory reserve margin for the power pool, the model shall throw a flag indicating that the power pool is in a deficit condition and that additional generation resources are required.
6. In future iterations of the algorithm, enhancements may be made to allow power to flow from one region to another.

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- a) If there is additional power in the excess generation pool, an examination shall be made to see if additional generation is available in an adjacent power pool to resolve the deficit in generation resources condition.
- b) The resolution of the deficit will need to account for the ability of the transmission system to handle the interchange flow.

III. Capacity assignments

- A. In the event that new unit information from the State is not sufficient to meet future demands, a “grow in place” strategy will be used to assign new generic generation to each ERTAC region for each ERTAC fuel/unit type bin.
- B. The amount of new generation needed for the region will be determined based on demand requirements.
 1. For demand requirements, after a certain number of hours are run in any particular ERTAC fuel/unit type bin and ERTAC region, the algorithm examines if any of the hours needed additional capacity. Since hours are assigned generation in order of most demand to least demand, the initial hours calculated should indicate whether or not a deficit in capacity exists. The default for this number of hours is 400. The value can be changed in the Input Variables spreadsheet. This will prevent the algorithm from running through 8,760 hours prior to determining if a new unit needs to be generated. Generating a new unit will necessitate rerunning the algorithm from the beginning.
 2. In the Input Variables spreadsheet, a demand cushion variable can be changed to reflect a multiplication factor for the demand deficit in an ERTAC region and ERTAC fuel/unit type bin. The default is 1.00.
- C. No new generic units will be created for reserve capacity deficits, at least for the initial development of the algorithm. A report will be generated detailing the reserve deficits.
- D. For capacity needed to meet demand in an ERTAC region and an ERTAC fuel/unit type bin:
 1. New units will be created based on the amount of capacity needed and the minimum and maximum sizes listed in the Input Variables spreadsheet.
 - a) Coal new unit size defaults: 300 MW minimum, 600 MW maximum.
 - b) Combined cycle new unit size defaults: 250 MW minimum, 500 MW maximum.
 - c) Simple cycle-gas new unit size defaults: 80 MW minimum, 160 MW maximum.
 - d) Boiler-gas new unit size defaults: 50 MW minimum, 150 MW maximum.

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- e) Oil new unit size defaults: 50 MW minimum, 150 MW maximum.
 2. Capacity will be created in the region and ERTAC fuel/unit type bin minimizing the number of units created. The amount of new capacity created must exceed the amount of the deficit.
 - a) Example: In a region for the coal ERTAC fuel/unit type bin, the algorithm runs for 400 hours and determines that the maximum deficit is 1,202.7 MW-hrs. The demand cushion is set at 1.1, so that 1,323.0 MW-hrs is needed to meet the deficit. Therefore, in that region, two 600 MW and one 300 MW coal fired units would be created.
 - b) Example: In a region for the simple cycle-gas ERTAC fuel/unit type bin, the algorithm runs for 400 hours and determines that the maximum deficit is 75 MW-hrs. The demand cushion is set at 1.05 so that 78.8 MW-hrs are needed. Therefore, in that region, on simple cycle gas new unit is created with a size of 80 MW.
 3. The first new generic unit will be “located” at the facility in that region that has the largest total (all fuels) capacity and burns that type of fuel. The second new unit will be “located” at the facility in that region that has the second largest capacity and burns that type of fuel, etc. Default data may be created by rank ordering the size of each facility. The top 10 facilities for each ERTAC region and ERTAC fuel/unit type bin are input variables. This data may be modified in the Input Variable spreadsheet.
 4. All generic new unit assignments will be documented in a report for that ERTAC region, to include size of units, location of units, fuel/unit type, hours when additional generation is needed, and why the additional generation is needed (either demand growth or reserve requirements).
 5. If new generic units are needed, these units will be added to the unit availability file in the same manner as State-specified units, with generic emissions factors for NO_x, SO₂, and CO₂(e) in the Emissions and Controls file. The generic emission factors will be the 90th percentile NO_x, SO₂, and CO₂(e) emission rates documented in that region for that fuel and unit type from CAMD data. (The units will be in the top 10th percentile in terms of cleanliness.) This percentile may be changed in the Input Variables spreadsheet. The new generic units will be treated identically to State-specified units in terms of proxy capacity, position in unit hierarchy, etc. The modeling program will need to be rerun with this data in the Unit Availability File and Controls and Emissions File to obtain final outputs.
- E. For capacity needed to meet reserve requirements in a region:
1. At this time, no new generic units will be created to meet reserve capacity requirements. Creation of generic units to meet reserve capacity requirements may be a future enhancement to the algorithm.

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2. The algorithm will create a report to provide data on the regions where reserve requirements are not met. The report should include hours of the year when reserve requirements are not met, the size of the deficit for reserve requirements, and the status of demand and reserve requirements in neighboring regions for the same hours.

IV. Control installation to meet emissions caps

A. Leadership

1. Addition of control equipment to uncontrolled units will be led by the States.
2. If it is necessary to add controls through the modeling process, the procedure described in Section IV.B will be used to assign controls. The assignments will then be reviewed by the States where the unit(s) are located to determine if the assignment appears reasonable.
3. It should be noted that model-assigned controls, even if deemed reasonable during the previous step, may not reflect the actual compliance decisions of individual entities with compliance obligations under a future program due to their individual analysis of the economic and other drivers of a control installation decision.

B. Control Assignment Methodology for Use in the Model

1. The primary source for the addition of emission control equipment for modeling purposes will be information supplied by the State agency where the source is located.
2. Emission levels to be used in the inventory will be transmitted with the control assignment by the State agency.
3. The age of any unit factors into the decisions regarding control installation. If no on-line start date is provided for a unit in the Unit Availability File, the program will assume that the age of the unit is appropriate for economical retrofit.
4. In the event that there is insufficient control of a pollutant in a region from existing control devices and known new controls identified in steps one and two of this section to meet the requirements of a regulatory program being examined, the following process will be utilized to close the gap in the inventory.
 - a) SO₂ Control Programs
 - (1) Units older than 50 years old will not be assigned controls to allow a minimum of 15 year payback period for the capital costs on units larger than 200 MW.
 - (2) Control assignment will be done using the earliest dispatch ordered unit meeting the age criteria that will not be retired

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in the future year and that does not have an emission control already installed.

- (3) Controls will be assumed to meet the proposed regulatory limit on the unit where the control is assigned or a 0.20 lb/MMBtu emission limit for SO₂ or a 93% reduction efficiency. IPM documentation indicated that SO₂ controls applied by IPM have a 98% reduction efficiency or a 93% reduction efficiency, depending on control type. Since IPM assumed a base rate of 3 lbs SO₂/mmbtu, a 93% reduction efficiency equates to approximately 0.2 lbs SO₂/mmbtu. The percent reduction value may be modified in the Input Variables spreadsheet.
- (4) Specific control types (wet or dry scrubber, or other SO₂ control device) will not be prescribed, only the emission rate.
- (5) In the event that program limitations continue to be unsatisfied, greater control may be assigned to units based on type of coal used. This would be a future enhancement to the program.
- (6) In the event that this does not generate sufficient reductions to meet the requirements of the control program, a report will be written indicating the area where the program requirements are not being met and the remaining units in the area that are not controlled.
- (7) Input variables for age limitations on the application of controls and for the control efficiency associated with controls may allow the adjustment of these factors.

b) NO_x Control Programs

- (1) The process used will assign both SCR and SNCR to units based on the criteria identified in the following sections
- (2) Uncontrolled units older than 50 years old and smaller than 200 MW will not be assigned SCR equipment, but will be assigned SNCR if they are less than 58 years old, larger than 100 MW, and not retired in the future year.
- (3) Uncontrolled fluidized bed boilers meeting the requirements in (2) above will only be assigned SNCR.
- (4) Control assignment will be done using the earliest dispatch ordered unit meeting the age and size criteria that does not have an emission control already installed. In the event that a unit already equipped with SNCR meets the criteria for SCR, it will not be upgraded to SCR.

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- (5) Units assigned SCR will be assumed to operate at an emission limit of 0.10 lb/MMBtu or any hard regulatory limit that would apply and SNCR equipped units will be assumed to operate at an emission limit of 0.15 lb/MMBtu.
- (6) Specific control types (SCR or SNCR) will be prescribed based on the above criteria.
- (7) In the event that this does not generate sufficient reductions to meet the requirements of the control program, a report will be written indicating the area where the program requirements are not being met and the remaining units in the area that are not controlled.
- (8) The controlled values for SNCR and SCR, as well as age and size requirements for the application of controls, may be modified in the Input Variables spreadsheet.

C. Transport Rule and Other State Cap Compliance Demonstrations

1. Order: Caps will be evaluated by reviewing the smallest time period first (for example ozone season NO_x caps), applying necessary controls to meet those caps, then reviewing larger time periods (for example annual NO_x caps).
2. State Level Functions
 - a) For states that are subject to transport rule requirements or that are subject to more stringent, state cap requirements, the algorithm will check to determine if state emissions levels in the future year will comply with the cap levels specified by state personnel for annual SO₂ emissions, annual NO_x emissions, and ozone season NO_x emissions.
 - b) State staff will specify cap levels for annual SO₂, emissions, annual NO_x emissions, and/or ozone season NO_x emissions in the State Total Listing. Adding a comment as to the origin of the state cap would be helpful for documentation. Also, commenter email address should be included.
 - c) In the event that any state emissions are above any level specified in the State Total Listing for that future year after consideration of all state-supplied information regarding new controls, fuel switches, and other reduction strategies, the algorithm will apply generic controls as described in Section IV.B. to that state's units until that state's emissions cap is met. States will be evaluated in the order they are listed in the State Total Listing.
 - d) Reporting for this function will be particularly important to ensure that state staff is able to easily discern the reasons for the application of generic controls.

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- e) If generic control is applied to demonstrate compliance with a cap for a short time period, for instance NO_x ozone season, that generic control will continue to apply when demonstrating compliance with the cap for a longer period of time, for instance NO_x annual, regardless of whether the additional control is needed to meet the longer period cap.

3. Group Level Functions

- a) For states that are subject to the transport rule requirements, the algorithm will check to determine if group level emissions in the future year comply with the cap levels for each group of states specified by state personnel for annual SO₂ emissions, annual NO_x emissions, and ozone season NO_x emissions.
- b) State staff will specify annual SO₂ emissions caps, annual NO_x emissions caps, and ozone season NO_x emissions caps for each group. State staff will also specify to which group each state belongs. These specifications will be made in the Group Total Listing. Supplying information in the comment field of that file as to the origin of the cap would be helpful for documentation purposes. Group caps will be evaluated in the order they are listed in the Group Total Listing. It is important to list shorter time period caps first in the table, such as ozone season, prior to longer period caps, such as annual.
- c) In the event that any group emissions are above any level specified in the Group Total Listing after consideration of all state-supplied information regarding new controls, fuel switches, and other reductions strategies, and after consideration of all generic controls applied in Section IV.C.2.c), the algorithm will apply generic controls as described in Section IV.B. to that group's units for that particular pollutant until that group's emissions cap is met.
- d) Reporting for this function will be particularly important to ensure state staff is able to easily discern the reasons for the application of generic controls.
- e) If generic control is applied to demonstration compliance with a state cap for any reason, the generic control will continue to apply when demonstrating control for relevant group caps, regardless of whether the additional control is needed to meet the group cap.

V. Reporting and Outputs

A. Outputs

- 1. The primary output of this model will be a file ready for either direct use in the photochemical model or merging with other inventory files for use in the photochemical model.

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2. Secondary outputs may quantify criteria and climate change pollutants on either an hourly or an annual basis.
- B. Reporting
1. The model will output various reports that identify deficiencies in generation and emissions controls in various regions to allow informed intervention by State staff.
 2. The model will also output a file identifying the units, peak hourly generation or heat input, and annual generation or heat input.