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New Regulatory and Technological Developments Impacting Air Pollution Construction Permitting for New Combustion Turbines

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Several recent technological and regulatory developments will impact the approach for obtaining air pollution construction permits for new combustion turbines (CTs). We examine the impact of each of these developments and discuss strategies for dealing with them.

INTRODUCTION

The growth in demand for electric energy over the past decade has led to a growth in demand for new power generating units such as simple cycle and combined cycle CTs. As a result, a large number of new generating projects utilizing CTs are in the planning, permitting or construction stage. These CTs are typically fired with natural gas and low sulfur distillate oil as a backup fuel.

The procedures for obtaining air pollution construction permits for these facilities are governed by federal, state and local regulations and guidelines. The principle existing federal regulations and guidance affecting sources such as CTs include PSD new source review [1], nonattainment area new source review [2], New Source Performance Standards [3], MACT [4] and the Guideline on Air Quality Models.[5] The main federal guideline outlining the detailed procedures for major source air permit preparation and analysis are given in the New Source Review Workshop Manual.[6]

States and local government agencies with their own permitting authority typically have additional rules and guidelines governing the permitting process. Some of these rules and guidelines deal with minor sources not subject to PSD and nonattainment area new source review requirements. Other state and local agency rules and guidelines deal with air quality modeling procedures and how to treat emissions of hazardous air pollutants under the state agencies' air toxics policy.

These government rules and guidelines may be organized into the following eight steps to obtain an air pollution construction permit for a proposed CT power project:

1. Calculate the potential to emit (PTE) of each air pollutant regulated under the Federal Clean Air Act (CAA) and the state and local air program.

2. Make an applicability determination as to which new source review requirements apply. Applicability is pollutant specific and will include a determination as to whether the source is a major source, synthetic minor source or natural minor source.

3. Conduct an air pollution control technology evaluation to satisfy the Federal permitting program requirements (i.e., BACT, LAER) and/or state and local control technology requirements.

4. If applicable, obtain permitting agency approval for the air quality modeling protocol; perform the analysis; and determine whether the source has significant air quality impacts. If so, conduct air quality modeling of the CT project emissions and background sources located within 50 kilometers and beyond to determine whether total PSD increment consumption exceeds the PSD increments in 40 CFR Part 52.21 and whether total concentrations exceed the National Ambient Air Quality Standards (NAAQS). Also conduct the air quality modeling required to satisfy the state and local government agency's requirements, including air toxics policy requirements if applicable.

5. If applicable, obtain permitting agency and Federal Land Manager (FLM) approval for and conduct long range transport modeling of PSD increment consumption, visibility impacts, and any air quality related values established in PSD Class I areas.

6. If the source is subject to nonattainment area permitting requirements, determine the amount of emission offsets required, and identify and obtain commitments for the emission offsets.

7. If applicable, secure commitments for nitrogen oxides (NO_x) offsets to satisfy the NO_x State Implementation Plan (SIP) call requirements, and sulfur dioxide (SO_2) allowances required under 40 CFR Part 75 (i.e., Federal Acid Rain Program).

8. Complete the applicable permit applications. This not only includes the requisite construction permit application, but may also include permit applications required under the Federal Acid Rain program and the Federal operating permits program (i.e., Title V operating permits program) at 40 CFR Part 70.

Several recent technological and regulatory developments will impact this approach for obtaining air pollution construction permits for new CTs. For each of these developments, we examine their impacts and examine strategies for dealing with them.

These developments are:

1. Selective Catalytic Reduction (SCR) control technology's growing technological feasibility for simple cycle CTs.

2. U.S. EPA new draft guidance for BACT analyses pertaining to the collateral environmental impacts of using SCR on combined cycle CTs equipped with dry low NOx burners.

3. U.S. EPA emission factors for hazardous air pollutants from oil and gas fired CTs.

4. U.S. EPA's revisions to the Guideline on Air Quality Models with AERMOD becoming the principal new recommended model for determining impacts within 50 kilometers.

5. New requirements and analytical tools for conducting PSD Class I impact evaluations, including: a) U.S. EPA's revisions to the Guideline on Air Quality Models, with CALPUFF becoming the new recommended model for long range transport modeling and visibility impacts in PSD Class I areas and b) Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Final Phase I Report for addressing the impact on air quality and air quality related values of sources located near Class I areas.

6. Expected promulgation by U.S. EPA of Maximum Achievable Control Technology (MACT) standards for new CTs.

7. The impending widespread nonattainment designations for the PM2.5 annual air quality standard.

USE OF SCR CONTROL TECHNOLOGY FOR SIMPLE CYCLE COMBUSTION TURBINES

Selective Catalytic Reduction (SCR) control technology for NOx control is beginning to become technologically feasible for simple cycle CTs. There are currently at least ten large (60+MW) simple cycle CTs with an SCR currently in operation or to be delivered in 2002.[(7)] Several of these are 80MW or larger.

This technology is evolving. The maximum exhaust gas temperature the catalysts in these SCRs can handle is currently about 1050ºF.[(7)] However, this temperature limit will also increase over time.

This development will affect the BACT, LAER and state air pollution control technology evaluations conducted in support of PSD construction permit applications for simple cycle CTs.

As a permitting strategy, it may be prudent to supplement the normal review of U.S. EPA's BACT/RACT/LAER Clearinghouse control technology determinations with a survey of SCR system and catalyst suppliers and users before determining the technological feasibility of SCRs for simple cycle CTs.

BEST AVAILABLE CONTROL TECHNOLOGY ANALYSES TO ADDRESS THE COLLATERAL ENVIRONMENTAL IMPACTS OF USING SCR ON COMBINED CYCLE COMBUSTION TURBINES WITH DRY LOW NO_X BURNERS

In August 2000, U.S. EPA released new draft guidance for BACT analyses pertaining to the collateral environmental impacts of SCR on combined cycle CTs equipped with dry low NOx burners.(8) This draft guidance states that in some situations the collateral environmental impacts associated with the use of ammonia with SCR may justify not requiring SCR on CTs equipped with dry low NO_x burners.

This development will affect the BACT analyses conducted in support of PSD construction permit applications. Evaluating the collateral environmental impact of SCR on combined cycle CTs equipped with dry low NOx burners should become an integral part of the control technology evaluation conducted. In some cases, it may also influence the government decisions on whether to require an SCR for this type of application.

NEW EMISSION FACTORS FOR HAZARDOUS AIR POLLUTANTS

In April 2000, U.S. EPA published final emission factors for hazardous air pollutants (HAPs) covered under the Clean Air Act Section 112(b) for gas and oil fired CTs.(9) These factors were published in U.S. EPA's reference emission factor document, AP-42.(10) Prior to April 2000, U.S. EPA had published draft factors largely based on limited test data.(11)

Tables 1 and 2 present the final factors together with the prior draft emission factors. For gas fired CTs, Table 1 shows that the emission factors for seven of the 11 HAPs reported have decreased and four have increased. The largest decrease was for naphthalene and the largest increase was for xylenes.

For distillate oil fired CTs, Table 2 shows that the emission factors for 10 of the 12 HAPs reported have increased and two have decreased. The largest decrease was for 1,3-butadiene and the largest increase was for chromium.

These tables also show that the HAP with the largest emission rate is formaldehyde for both gas and oil fired CTs.

These new emission factors will affect the applicability determinations for satisfying the various regulatory requirements for obtaining a construction permit including whether the proposed CT is a major source regarding HAPs and subject to MACT requirements.

Permitting strategies involving HAP emissions from new CT power projects will primarily involve decision making on control technology since a permitting authority will focus on whether the new project is a major source of HAP emissions (i.e., PTE 10 tons per year or more of a single HAP or 25 tons per year or more of total HAPs) and therefore subject to MACT.

If the CT is a major HAP source, it will be subject to the emission standards; control requirements; and testing, monitoring, record keeping and reporting requirements of the pending MACT standard to be issued for CTs pursuant to 40 CFR Part 63 as discussed later in this paper. Until this MACT is promulgated, CTs that are major sources for HAPs will be subject to case by case MACTs as required under Section 112(j) of the 1990 Clean Air Act Amendments.

As a permitting strategy, the source may wish to perform a cost-benefit analysis to determine whether it would be more economical to limit operations and HAP emissions to avoid MACT requirements, or to simply incur the capital and operating costs of the required MACT control system. The source may also not wish to rely on the emission factors for HAP emissions in AP-42 but instead require the selected CT supplier to run emission tests on the CT or CT model being supplied for determining whether actual HAP emissions will vary from those in AP-42.

REVISIONS TO THE GUIDELINE ON AIR QUALITY MODELS

In June 2000, U.S. EPA held its 7th Modeling Conference to announce proposed revisions to the Guideline on Air Quality Models. AERMOD and ISC PRIME were the principal new recommended models for use within 50 kilometers of a source. Following receipt of comments, U.S. EPA decided to incorporate the building and stack effect downwash features of ISC Prime into AERMOD so that a single Guideline Model, AERMOD, could be specified for most air quality modeling applications within 50 kilometers of a source. This work has been completed and evaluations of the accuracy of the revised AERMOD Model are underway. [12]

U.S. EPA is proposing to require use of this model as the preferred model in permit applications starting one year after U.S. EPA issues the final revised Guideline, with the option of this model being used as soon as U.S. EPA issues the revised Guideline. The comment period on these proposed revisions ended August 20, 2000 and the final revised Guideline is now projected to be issued in 2002.[12]

These revisions to the Guideline will affect the modeling procedures used to determine significant air quality impacts, PSD increment consumption and compliance with air quality standards.

For complex terrain (ground elevation exceeding stack height elevation), the model evaluation studies conducted by U.S. EPA indicate that concentration predictions with AERMOD will tend to be lower and more accurate than those predicted with the model previously recommended in the Guideline for complex terrain, COMPLEX I. For building and stack effect downwash, the new algorithm in ISC Prime and now in AERMOD predicts concentrations more accurately but does not necessarily predict lower concentrations.

NEW REQUIREMENTS AND ANALYTICAL TOOLS FOR CONDUCTING PSD CLASS I IMPACT EVALUATIONS

At the 7th Modeling Conference, U.S. EPA also announced proposed use of the CALPUFF Model as the preferred model for predicting concentrations beyond 50 kilometers from a source and predicting visibility and pollutant deposition impacts at the same distances.

In December 1998, U. S. EPA issued the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts.(13) The report represents recommendations and background information on how to address the impact on air quality and air quality related values (AQRVs) of sources located near Class I areas. This report was followed in October 1999 by the Federal Land Manager's Air Quality Related Values Workgroup (FLAG) Draft Phase I Report and in December 1999 by the Final Phase I Report.(14)

The FLAG Final Phase I Report is the basic guidance FLMs are now using to establish air quality and visibility analysis requirements for sources locating sufficiently close to PSD Class I areas and other areas under the responsibility of FLMs.

As stated in the FLAG Final Phase I Report, the goals of this report are to provide consistent policies and processes both for identifying AQRVs and for evaluating the effects of air pollution on AQRVs, primarily those in Federal Class I air quality areas, but in some instances, in Class II areas. Also, the primary areas of concern to the FLMs with respect to air pollution emissions are visibility impairment, ozone effects on vegetation, and effects of pollutant deposition.

Air quality modeling of PSD Class I increment consumption, visibility changes and pollutant deposition are recommended. If significant impacts occur, modeling of cumulative impacts of all sources consuming PSD increments is recommended.

The recommended trigger levels of significant air quality impact and significant visibility impairment in the FLAG Report are sufficiently small so that a moderate size (e.g. 400 MW) gas fired CT facility within a hundred kilometers of a PSD Class I area could easily exceed these significance definitions and thereby have the FLM require that cumulative impacts be assessed.

These regulatory developments may have a major impact on strategies for permitting new CTs. First, at the start of the permitting process it is important to understand the potential impacts in PSD Class I areas of the proposed new CT facility. While the FLAG Report recommends that sources within 200 kilometers of PSD Class I areas be evaluated, there is no scientific limitation on how far from the PSD Class I area a source can be and still use CALPUFF to assess air quality impacts.

Second, it is important to confer with the FLM responsible for the closest PSD Class I areas to agree on an approach to take in the air quality analysis. Usually this approach will begin with a screening modeling analysis using CALPUFF with very conservative input parameters. If significant impacts are predicted in the Class I area, less conservative input parameters may be agreed to in the screening modeling analysis with CALPUFF. If significant impacts still occur, a cumulative impact analysis including other PSD increment consuming sources using CALPUFF in the screening mode may be conducted.

As a final step, refined modeling analysis using three dimensional wind fields may be required. While only limited refined modeling has been conducted to date, there will probably be a considerable increase in this level of modeling as the FLAG Report recommendations begin to be implemented by the FLMs and national databases of three dimensional wind fields are developed and made available for use by modelers.

There will be additional requirements for conducting PSD Class I area impact evaluations as a result of U.S. EPA's July 1999 final rule addressing Regional Haze [15] . This rule basically requires states to submit "Planning" SIPs by 2004 and "Control Strategy" SIPs by about 2008. These "Control Strategy" SIPs may impose further requirements on the PSD Class I Area impact analyses and on the required emission controls for new CTs.

To address the Regional Haze Rule, as part of the permitting process it may be useful to conduct a limited number of contingency analyses of likely control requirements under various " Control Strategy" SIPs and design control systems for the CT to be able to respond to such requirements in the future in a cost effective manner.

Finally, all of these developments affecting PSD Class I Areas translate into added time and cost to complete the permitting process and greater uncertainty in the ultimate control requirements for the proposed source.

EXPECTED PROMULGATION OF MACT STANDARDS FOR NEW COMBUSTION TURBINES

The MACT emission standard for new CTs is expected to be proposed in 2002.

U.S. EPA formed a stakeholder workgroup, the Industrial Combustion Coordinated Rulemaking Coordinating Committee (ICCR) to provide input to U.S. EPA on this standard. Various stack emissions testing and cost effectiveness analysis studies were conducted.

Current U.S. EPA thinking for this MACT is as follows [16]. The MACT will apply only to CTs with output capacity of 1 MW or more operating 50 hours or more per year with certain other exemptions. It will require a reduction in carbon monoxide (CO) emissions by 95% through installation of an oxidation catalyst or a reduction in emissions of formaldehyde to a ppb level yet to be decided. There will be no difference in the MACT between oil and gas firing and between simple cycle and combined cycle CTs. U.S. EPA is also considering adopting a 4-hour rolling average compliance time for all MACT standards.

Until this MACT is promulgated, new CTs that are major sources of HAPs will be subject to case by case MACTs as required under Section 112(j) of the 1990 Clean Air Act Amendments.

This regulatory development translates into additional capital costs for air pollution control systems and additional operating costs for the monitoring and reporting to be required for the MACT.

THE IMPENDING WIDESPREAD NONATTAINMENT DESIGNATIONS FOR THE PM2.5 ANNUAL AIR QUALITY STANDARD

In July 1997, U.S. EPA promulgated a National Ambient Air Quality Standard (NAAQS) for fine particulate matter with an aerodynamic diameter of 2.5 microns or less (PM2.5). States were required to establish a PM2.5 monitoring network by 1999. After three years of monitoring data collection, states are to make proposed attainment and nonattainment designations. Following U.S. EPA promulgation of final designations, states must develop SIP revisions for attaining the NAAQS for PM2.5.

These developments will have major impacts on the future permitting of CTs.

The annual NAAQS for PM2.5 is 15.0 micrograms per cubic meter (ug/m3) based on a three year rolling average.

PM2.5 air quality monitoring data has been collected and reported by the states to U.S. EPA for 1999 and 2000. A summary of the results of this monitoring is given in Table 3 for 29 states in the eastern half of the U.S. These results show 23 of these 29 states have one or more counties with 1999-2000 annual average PM2.5 concentrations exceeding 15.0 ug/m3.

In 1999, a federal law was passed including a section establishing specific new deadlines for states to commence their PM2.5 monitoring programs, to make proposed attainment and nonattainment designations of the PM2.5 standards and to develop and submit their SIP revisions for attaining these standards [17] .

Specifically, the 1999 law requires states to have their complete PM2.5 monitoring program in operation by December 31, 1999 and to submit their proposed attainment and nonattainment designations to U.S. EPA within one year after receipt of three years of air quality monitoring data.

Since many states began operation of their PM2.5 monitoring programs at the start of 1999, this means proposed designations will be submitted to U.S. EPA between December 2002 and December 2003.

U.S. EPA must promulgate the final attainment and nonattainment designations for each state by the earlier of one year after state submittal of its proposed designations or no later than December 31, 2005.

For any area designated as attainment or unclassifiable for such standard, SIP revisions must be submitted to U.S. EPA within one year after U.S. EPA's final designations. For areas designated as nonattainment, SIP revisions for attaining the standards must be submitted within a schedule established by U.S. EPA but no later than three years after U.S. EPA's nonattainment designation.

Finally, under Section 172 of the 1990 Clean Air Act Amendments [18] , U.S. EPA must promulgate the SIP revisions received by the states (if complete) within 12 months of receipt. These SIP revisions must achieve attainment of the PM2.5 ambient air quality standards as expeditiously as practical but no later than five years from the date of nonattainment designation by U.S. EPA.

How do these schedules affect the permitting for new CTs? For CTs locating in attainment areas, the earliest the SIP revision can be in place is December 2005 and the latest is December 2007. For CTs locating in or near nonattainment areas, the earliest date is December 2007 and the latest is December 2009.

These SIP revisions will almost certainly include provisions to comply with the Emission Offset Interpretive Ruling [19] requiring major new sources and major modifications to existing sources to obtain emission reductions (offsets) from existing sources that exceed the emissions from the new source among other requirements.

Except for a shutdown or reduction in the permitted maximum operating hours for an existing source, it will be difficult and very costly to create these emission offsets since the cost of particulate control increases exponentially as particle diameter decreases.

Sulfur dioxide, nitrogen oxides and volatile hydrocarbon emission reductions are being considered for use in California as emission offsets for new sources locating in PM10 nonattainment areas because of the secondary formation of PM10 from these precursors [20]. It is possible that these other pollutants will be considered for PM2.5 emission offsets when such offsets are needed later in this decade.

Until these SIP revisions are promulgated, permitting requirements for combustions turbines may not change. However, it would be prudent to design new CTs with the capability of cost effectively adding additional particulate emission control equipment in the future to satisfy the expected requirement for PM2.5 emission offsets in many areas.

CONCLUSIONS

The new technological and regulatory developments discussed in this paper will increase the complexity, time and cost of obtaining air pollution construction permits for new CTs. This means that organizations planning to develop such projects must allow additional time and costs for satisfying the expected permitting requirements and for the contingencies that may occur. They should also adapt to these developments with new permitting strategies such as the ones discussed in this paper.

While air pollution permitting of new power generation capacity has always been a highly specialized process, these new developments will only increase further the complexity of this process.

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KEY WORDS

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Table 1. Comparison of Emission Factors for Hazardous Air Pollutants from Natural Gas Fired Stationary Gas Turbines.

	Emission Factor (lb/MMBtu)		Percent Change
	April 2000 Supplement F for AP-42	July 1998 Supplement D for AP-42	
1,3-Butadiene	<4.3 E-07	<4.31E-07	-0.2 %
Acetaldehyde	4.0 E-05	7.84E-05	-96.0 %
Acrolein	6.4 E-06	7.75E-06	-21.0 %
Benzene	1.2 E-05	1.37E-04	-1,041.7 %
Ethylbenzene	3.2 E-05	2.35E-05	26.6 %
Formaldehyde	7.1 E-04	3.33E-03	-369.0 %
Naphthalene	1.3 E-06	1.37E-04	-10,438.5 %
PAH	2.2 E-06	1.76E-04	-7,900.0 %
Propylene Oxide	<2.9 E-05	<2.84E-05	2.0 %
Toluene	1.3E-04	1.27E-04	2.3 %
Xylenes	6.4E-05	2.65E-05	58.6 %

Table 2. Comparison of Emission Factors for Hazardous Air Pollutants from Distillate Oil Fired Stationary Gas Turbines.

	Emission Factor (lb/MMBtu)		Percent Change
	April 2000 Supplement F for AP-42	July 1998 Supplement D for AP-42	
1,3-Butadiene	<1.6E-05	5.90E-05	-268.7 %
Benzene	5.5E-05	5.47E-05	0.5 %
Formaldehyde	2.8E-04	2.30E-04	17.8 %
Naphthalene	3.5E-05	3.09E-05	11.7 %
PAH	4.0E-05	3.09E-05	22.7 %
Arsenic	1.1E-05	7.91E-06	28.1 %
Beryllium	3.1E-07	3.31E-07	-6.8 %
Cadmium	4.8E-06	3.24E-06	32.5 %
Chromium	1.1E-05	6.76E-06	38.5 %
Lead	1.4E-05	1.08E-05	22.8 %
Manganese	7.9E-04	4.32E-04	45.3 %
Mercury	1.2E-06	6.26E-07	47.8 %
Nickel	4.6E-06	8.63E-05	-1,776.1 %

Table 3. Percentage of Counties in Selected States Projected to be Non-Attainment for the PM2.5 Annual Standard Based on 1999-2000 Annual Average Concentration.

States	Total No. of counties with PM2.5 Samplers	No. of counties with average conc. of greater than 15.0 ug/m3	% counties exceeding 15.0 ug/m^3
Alabama	17	16	94.1
Arkansas	18	6	33.3
Connecticut	4	1	25.0
Delaware	3	1	33.3
Florida	19	0	0.0
Georgia	20	20	100.0
Illinois	19	9	47.4
Indiana	18	8	44.4
Kentucky	18	8	44.4
Louisiana	17	0	0.0
Maine	9	0	0.0
Maryland	7	3	42.9
Massachusetts	10	0	0.0
Michigan	18	1	5.6
Mississippi	15	10	66.7
New Hampshire	7	0	0.0
New Jersey	12	3	25.0
New York	22	4	18.2
North Carolina	30	21	70.0
Ohio	19	16	84.2
Pennsylvania	24	10	41.7
Rhode Island	3	1	33.3
South Carolina	15	5	33.3
Tennessee	14	13	92.9
Texas	24	1	4.2
Vermont	4	0	0.0
Virginia	17	7	41.2
West Virginia	14	10	71.4
Wisconsin	18	0	0.0