Air Emissions Source Permitting Programs in the United States and European Union:

Lessons for China

A product of the Clean Air Alliance of China and the Energy Foundation China in support of related rule development and implementation efforts by Chinese air quality regulators.

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This paper was developed with input from Christopher A. James, the Regulatory Assistance Project; Rebecca A. Schultz, the United States Environmental Protection Agency; and Alex Radway, Environment Agency, England (United Kingdom). The purpose of this paper is to provide information to support a dialogue and discussion with China regarding related rule development and implementation. It is not intended to provide legal advice or represent the legal views of any government entity.

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List of Acronyms

BACT	Best Available Control Technology
BAT	Best Available Techniques
BREFs	BAT Reference Documents
CAA	Clean Air Act
CAM	Compliance Assurance Monitoring
CARB	California Air Resources Board
CEMS	Continuous Emissions Monitoring Systems
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide-Equivalency
EPA	Environmental Protection Agency
EU ETS	EU Emissions Trading System
GHG	Greenhouse Gas
HAPs	Hazardous Air Pollutants
IED	Industrial Emissions Directive
IPPC	Integrated Pollution Prevention Control
LAER	Lowest Achievable Emission Rate
LCP	Large Combustion Plant
MACT	Maximum Achievable Control Technology
MW	Megawatts
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
N_2O	Nitrous Oxide
NOx	Nitrogen Oxides
NSPS	New Source Performance Standards
NSR	New Source Review
OPRA	Operational Risk Assessment
Pb	Lead
PFCs	Perfluorinated Compounds
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
SIPs	State Implementation Plans
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
TPY	Tons Per Year

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Part I: An Overview of Air Permitting Programs in the United States and European Union

General Principles

Pollution control systems in the United States and European Union rely heavily on permitting as a key regulatory vehicle for limiting emissions, coordinating local decisions with national targets, and ensuring compliance. Transparent and consistent operation of environmental permitting systems promote a positive climate for investment and commerce, contributing to a level playing field by bringing all covered pollution sources into a common compliance system, thereby eliminating the economic advantage of non-compliance. While unique policy and legal contexts shaped the development of air permitting programs in the United States and European Union, there are general principles learned over the course of several decades of implementation that are especially relevant to a government designing new rules today. Key principles to take into consideration in a stationary source air permitting program include:

1. **Building continuity between emissions at their source and air quality goals.** In international experience, the permit has proven to be an important regulatory vehicle through which environmental authorities can ensure that allocations of allowable emissions align with national targets, regulations, and legislation.

2. **Including mechanisms to balance economic growth and environmental impacts.** The stringency of the pollution control requirements can account for local air quality and provide more flexibility to take control costs under consideration where air quality goals are being achieved.

3. **Assuring compliance with applicable requirements.** All permits must include clear emissions and work practice limitations to assure compliance with the applicable requirements, as well as associated monitoring, record keeping, and reporting to demonstrate compliance.

4. **Conferring adequate management authority on the environmental agency at the national level.** A strong oversight authority at the central level, with clearly defined responsibilities across tiers of government, can help to guarantee effective implementation and consistent performance across different jurisdictions. This may prove particularly important in addressing sources in a large and economically diverse country like China.

5. **Incentivizing compliance.** Permitting requirements and procedures can be designed to facilitate compliance determinations and simplify enforcement, for example by engaging the enterprise in the process of drafting the permit, holding executives personally accountable for compliance reporting, and automating compliance incentives and enforcement penalties based on continuous emissions reporting. A regulatory framework that creates incentives for facilities to improve performance beyond mandatory requirements, whether through financial mechanisms (e.g., a facility pays more for greater volumes of emissions) or public disclosure of information (i.e., a facility may voluntarily rectify poor performance), can help engender better outcomes on an ongoing basis.

6. **Providing transparency.** Transparency in all stages of the regulatory process establishes a basis of accountability in environmental governance. An effective permitting program will provide: clear rules and procedures; clear obligations and standards; clear consequences for violating the rules; explicit reasons for permit decisions; and public access to draft and final permits and compliance data.

7. **Engaging the public in the decision-making process**. Public engagement leads to more robust and informed decisions. It engenders trust and accountability in the regulatory process and creates a valuable counterweight to the powerful economic interests of the permit applicant.

8. **Streamlining to balance efficiency and effectiveness**. A key lesson learned in permitting has been that while one size does not fit all, permitting is also highly time and resource intensive. Program design needs to strike a balance between efficiency and effectiveness.

9. **Ensuring the program has adequate and secure sources of funding.** Developing and renewing permits, conducting site inspections, and verifying and enforcing compliance are all resource intensive activities and require trained staff. Funds needed to run permitting programs should be adequate, sustained, and sheltered from budgetary uncertainty.

Keeping these principles in mind can help frame questions about regulatory design as they emerge in the discussion that follows.

Overview of US Permitting Programs

Air pollution permitting developed in the United States against a unique backdrop of historical, institutional, and legislative circumstances, as enacted through the Clean Air Act, specifically:

- The 1977 amendments to the Clean Air Act, which created the preconstruction permit program for new and modified facilities known as the New Source Review (NSR) program;[1] and
- The 1990 amendments, which created the operating permit program known as Title V.[2]

The US Enviromental Protection Agency's (EPA) Office of Air and Radiation is responsible for overseeing national implementation of these programs. The programs are mostly administered by state and local environmental agencies, with support from EPA regional offices. The state and local air agencies are approved or delegated to administer these programs according to legal processes and minimum program requirements specified by EPA, which retains some permitting, oversight, and enforcement authority.[3]

Permitting programs for water emissions and hazardous waste were established independently through the Clean Water Act and Resource Conservation and Recovery Act. These permitting programs are implemented by the Office of Water and Office of Resource Conservation and Recovery, respectively.

[1] Basic information about the NSR program can be found online at https://www.epa.gov/nsr.

[2] Basic information about the Title V program can be found online at https://www.epa.gov/Title-v-operating-permits.

[3] The Clean Air Act provides the EPA with the authority to object to the issuance of deficient permits, and to issue a federal permit where a state does not have an approved or delegated program.

The US Clean Air Act

This introduction is intended to provide a basic overview of the Clean Air Act (CAA) to facilitate an understanding of the two key permit programs established in that federal law: the preconstruction and operating permit programs.

The CAA is a federal statute enacted by Congress which provides the EPA with the authority to implement air quality programs, and to coordinate such implementation with state and local governments. Congress established much of the basic structure of the CAA in 1970, and it has since been amended, most recently in 1990.[4]

One main component of the CAA is the development and establishment of national ambient air quality standards (NAAQS) for six common air pollutants. These common air pollutants (also known as "criteria pollutants") are found all over the United States and can harm health and the environment and cause property damage.[5] The six pollutants are particle pollution (often referred to as particulate matter), photochemical oxidants and ground-level ozone, carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead (Pb).

When the EPA establishes a new NAAQS or revises an existing standard for one of the criteria air pollutants, it sets in motion a series of actions aimed at ensuring that air quality throughout the country meets those standards. The EPA must designate areas as meeting (attainment) or not meeting (nonattainment) the standard. The CAA requires states to develop a general plan to attain and maintain the standards in all areas of the country and a specific plan to attain the standards for each area designated nonattainment. These plans, known as State Implementation Plans or SIPs, are developed by state and local air quality management agencies and submitted to the EPA for approval. As a general matter, SIPs serve two main purposes: (1) demonstrate that the state has the basic air quality management program components in place to implement a new or revised NAAQS; and (2) identify the emissions control requirements the state will rely upon to attain and/or maintain the NAAQS.

The CAA's preconstruction permitting program, or the "New Source Review" program, is an important part of state and local area plans to attain and maintain the NAAQS. The CAA's operating permit program, while not submitted to the EPA as part of state and local implementation plans, does serve to ensure that sources are complying with emission limits that are required by the state implementation plans.

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[4] A basic introduction to the Clean Air Act, including the permitting programs, is provided in: US EPA. *The Clean Air Act in a Nutshell: How It Works*. Retrieved from https://www.epa.gov/sites/production/files/2015-05/documents/caa_nutshell.pdf

[5] The EPA calls these pollutants "criteria" air pollutants because it sets standards for them based on human health or environmental criteria (characterizations of the scientific information). The set of standards based on human health for protection of public health are called *primary standards*. Another set of standards intended to prevent environmental and property damage for protection of public welfare are called *secondary standards*. Where a criteria pollutant is actually a group of pollutants (e.g., nitrogen oxides), the standards are set for key or indicator pollutants within the group (e.g., nitrogen oxide). For more information see: https://www.epa.gov/criteria-air-pollutants.

Stationary Source Permitting under the Clean Air Act

The US stationary source permitting system includes two key types of permits–a preconstruction permit and an operating permit. Within these two main permit types are permits for major sources and minor sources. Major sources are those emitting above a certain number of tons per year of particular pollutants. Minor sources are those emitting below a specified threshold but to which some emissions-related obligations still apply. In addition, the CAA generally provides that states may have more stringent programs than the federal program and so states may impose additional permitting requirements on sources–although generally this does not occur.

As a result of the incremental development of these programs, the US system separates pre-construction and operating permit programs; however, separate programs are not necessarily needed to effectively evaluate and control air emissions associated with both preconstruction and operation. In the United States, some state permitting authorities issue combined construction and operating permits but do not allow the facility to initiate operation until after an inspector verifies that the enterprise has been built consistently with the preconstruction permit.

1. Preconstruction Permit Programs

For a new or significant modification to a major stationary source, an enterprise must meet specified requirements under the NSR program to obtain a preconstruction permit before construction starts. There are two different preconstruction programs: one for areas of the country that the EPA has determined to be in attainment with the NAAQS, called "Prevention of Significant Deterioration" or PSD; and the second for areas that EPA has determined are not in attainment with the NAAQS, or "Nonattainment New Source Review." Requirements for sources in attainment areas through the PSD program are less stringent than those for sources in nonattainment areas.

The PSD program includes two primary elements: (1) an analysis ensuring that the proposed facility is subject to the "Best Available Control Technology" or BACT for each pollutant subject to regulation under the PSD program, and (2) an evaluation of the impact of the proposed new or modified major stationary source on ambient air quality in the area.

New and modified facilities use BACT to minimize emissions of regulated pollutants from the facility. BACT is defined as an emissions limit based on the maximum degree of reduction that the permitting authority determines is achievable for a facility. The permitting authority makes that determination through considering a broad range of pollution reduction approaches, including production processes and available methods, systems, and techniques, including fuel cleaning, fuel treatment, switching to cleaner fuels, or innovative fuel combustion techniques for control of each pollutant. The permitting authority determines BACT on a case-by-case basis for each regulated unit, taking into account energy, environmental, and economic impacts and other costs.

The EPA has developed a "top-down" analysis for permitting authorities to use in determining BACT. It consists of a five-step process which provides that all available control technologies be ranked in descending order of control effectiveness, beginning with the most stringent. The most stringent control technology is deemed necessary unless the applicant demonstrates to the satisfaction of the permitting authority that technical, energy, environmental, or economic factors make it infeasible. The five steps in the top-down process are summarized below:

1) Identify all available control technologies;
2) Eliminate technically infeasible options;
3) Rank remaining control technologies by control effectiveness;
4) Evaluate the economic, environmental, and energy impacts of the options; and
5) Select BACT.[6]

In addition to BACT, the PSD program also includes an obligation that emissions from new or modified facilities will not adversely impact ambient air quality. In developing a permit application, a facility is required to undertake an air quality modeling analysis to demonstrate that emissions from construction or operation of the facility will not cause air pollution in excess of any NAAQS or air quality "increment." In areas that are in attainment with the NAAQS, air quality increments represent a maximum allowable increase in a particular pollutant concentration above baseline levels.

In areas that are not in attainment with the NAAQS, the "Nonattainment New Source Review" program applies. Under this more stringent program, states are required to ensure that new major stationary sources do not further degrade air quality. This includes a requirement that new sources install controls at least as effective as the best performing source of that same category anywhere in the country.[7] The emissions limit is established in each individual permit and is called the "lowest achievable emission rate" or LAER. New sources must also offset projected emissions through reductions in pollution from existing facilities in the area. A company can obtain offsets by reducing emissions from other facilities it owns, buying emissions credits from another company that reduces emissions, or closing down an old plant. A minimum offset ratio is set at 1:1 and can be as high as 1.5:1 (see Table 1). Permit applicants may also be required to undertake air quality modeling analyses of alternative sites to construct a new or expand an existing facility.

2. Operating Permits Program

The operating permits program under the CAA is known as "Title V" for the section of the law that describes it. The CAA calls upon each state to develop and submit to the EPA an operating permit program to meet requirements outlined in Title V of the law. All major stationary sources of air pollution are required to apply through a state's operating permit program for Title V permits. These permits do not generally impose new substantive air quality control requirements, but specify emissions limitations and other conditions to assure compliance with applicable requirements of the CAA, including the requirements of the SIP and of the preconstruction permit.

One purpose of the operating permit program is to allow the source, the EPA, states, and the public to better understand the applicable requirements to which the source is subject and whether the source is complying with those requirements. Thus, the operating permit program is a vehicle for ensuring that existing air quality control requirements are appropriately implemented and that compliance with these requirements is assured.

Operating permits must include all "applicable requirements." Applicable requirements under the operating permits program include, for example, the terms and conditions of the preconstruction

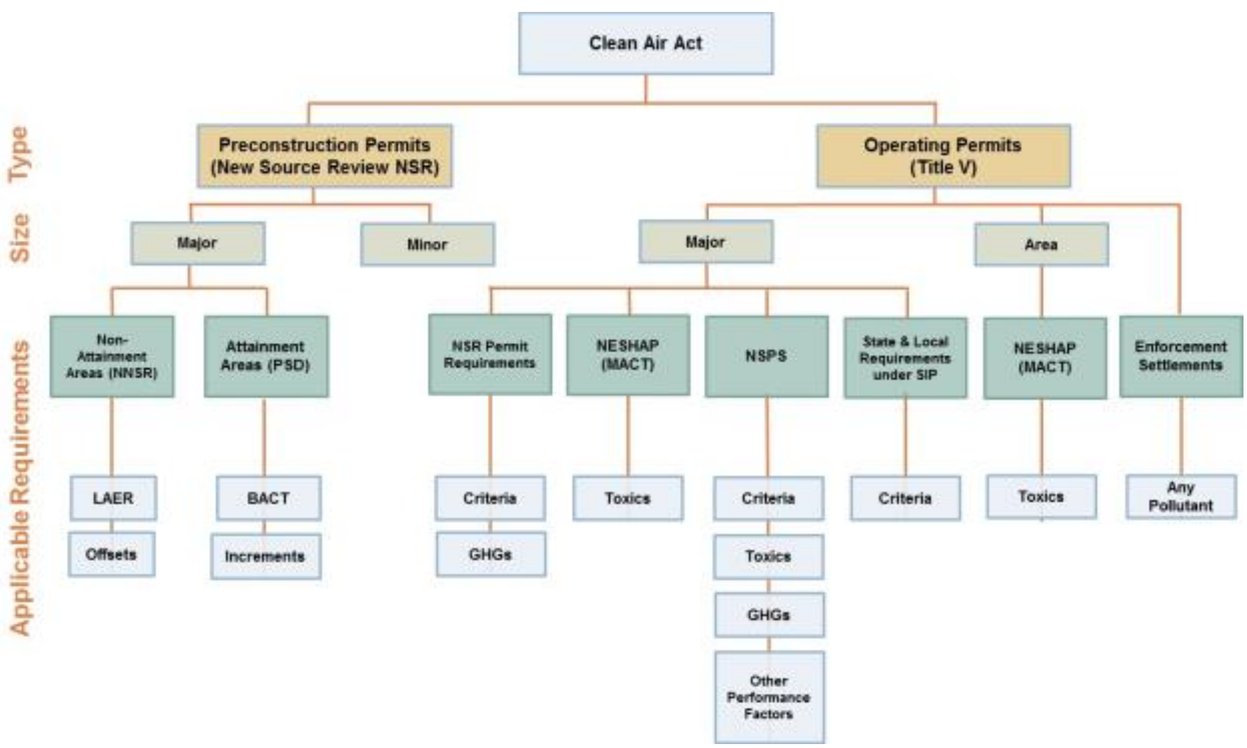
[6] Although the EPA regulations do not require this top-down analysis, permitting authorities frequently use it to ensure that it has reached a defensible BACT determination, including consideration of all applicable control alternatives.
[7] LAER requirements are defined as the most stringent emissions limit contained in any state air quality plan or achieved in practice within a source category. RACT/BACT/LAER Clearinghouse is available at https://cfpub.epa.gov/RBLC/index.cfm?action=Home.Home&lang=en

permit. Applicable requirements also include new source performance standards (NSPS), national emissions standards for hazardous air pollutants (NESHAPs), and any terms and conditions from state implementation plans. The operating permit thus includes all requirements applicable to the facility in one permit–even though the particular emissions limits derive from numerous different requirements under state, local, or federal regulation. Figure 1 illustrates a taxonomy of applicable requirements under the preconstruction and operating permit programs. To accommodate any new requirements affecting a facility, a permit may be reopened and modified during its permit term or it can be modified during the renewal process.[8] The operating permit, therefore, has flexibility to incorporate new applicable regulations as they are issued.

Under the operating permits program, the permitting authority has the ability to add additional monitoring, recordkeeping, and reporting specifications as necessary to assure compliance with the terms and conditions of the permit. These specifications include schedules for monitoring and recordkeeping, annual compliance certification details, and requirements to report any deviations from the terms of the permit. Monitoring, recordkeeping, and reporting requirements are a key element of the operating permit program because a principle of this program is to assure compliance.

Figure 1 shows taxonomy of applicable requirements by source size, emissions type, and attainment status as covered by the preconstruction and operating permitting programs. Permitting programs under the CAA distinguish between major and minor sources of pollution, and an area's status of attainment with the NAAQS, and treat criteria, greenhouse gas, and toxic emissions differently.

Figure 1: Clean Air Act Requirements



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[8] A permit may be reopened to incorporate requirements that become applicable during the permit term (five years), but this is generally mandated only if the permit has at least three years left in its term. See Clean Air Act, 40 CFR §70.7(f)(1)(i).

3. *Permitting Procedures*

Having explicit, transparent, and predictable procedures (i.e., for disclosing information to the public, providing opportunities for comment and judicial review, revising permits to include new emissions standards, etc.) affords an opportunity for all parties to participate. This has the effect of delegating responsibility, for example, to the public to provide decision-makers with the information it wants considered.[9] In this way, the permitting *process* may be as important as the *content* of the permit in creating accountability and ensuring effective regulation. A challenge in developing a robust permitting program is striking a balance between process and related procedural requirements, and the burdens that they impose.

In the preconstruction permitting process under the NSR program, once the emission limits are established, such as through the BACT or LAER process, then the permit is drafted by the state or local agency. The permit draft, along with all supporting documentation, is made available for public comment for at least 30 days. During this time anyone can comment on the permit, including the general public, industry, non-governmental organizations, state governments, EPA, and other federal agencies.[10] After the comment period, the permitting authority evaluates the comments received and typically prepares a response to the comments which explains the decisions to accept or reject comments and make or not make changes to the permit accordingly. The permit is then issued along with the response to comments document. In cases where the permitting authority significantly revises the draft permit, it may solicit public comment again on the revised permit. Permits can also be appealed through judicial review.

The permitting procedures under the operating permits program is similar to that for the NSR program, with some key differences.[11] One key difference is that under the operating permits program, the EPA is afforded a separate review period of 45-days before the permit is issued. (See Figure 2.) At this stage, the EPA has the authority to "object" to a permit.[12] An EPA objection would be based on a finding that the permit does not comply with the applicable requirements of the CAA. An objection would typically require the state or local air agency to better explain its decision or make additional changes to the permit in order to ensure that it complies with the CAA. If the EPA does not object during the 45-day review period, any person may petition the EPA to object to the permit. Of the approximately 15,000 major stationary sources that are permitted nationally in the United States, the EPA receives a very small number of petitions per year. The EPA's responses to petitions are publicly available, and under some circumstances are subject to judicial review. If the EPA does not object to the permit and no petition is filed, then the final permit is issued.

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[9] The public can raise issues that might not otherwise be a part of the information before the decision-making agency or permitting authority. For example, the public may have relevant and useful information based on personal experience that was not shared by the source in the application process. Generally, under the US system, in order to seek judicial review of permits, issues or comments must be raised with "reasonable specificity" during the public comment and review process. In this way, the public input opportunities can also serve to limit the availability of judicial review following final permit issuance. The integration of public feedback also supports successful operation moving forward where, for example, there may be a more positive relationship between the source and the public if the public had an opportunity to voice concerns and impact the content of the permit.

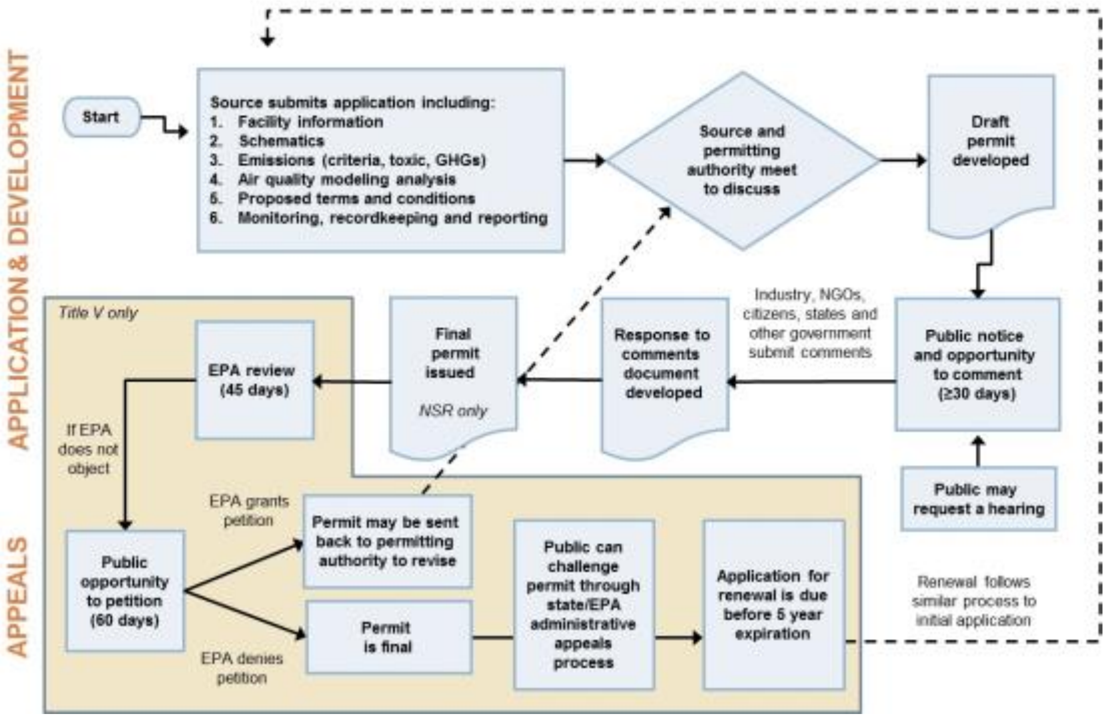
[10] Note that certain federal agencies will have additional opportunities to comment on the permit later in the permitting process.

[11] Although state and local areas have somewhat different rules regarding precisely when an operating permit must be obtained, ultimately any major stationary source that is required to have an NSR permit will need to obtain an operating permit.

[12] The EPA issues some operating permits itself, in which case there is no 45-day review period for the Agency to object.

Figure 2 represents a flow chart of permitting processes in the United States, including elements of both the preconstruction (NSR) and operating (Title V) permit programs. It is intended to be illustrative and does not capture all potential outcomes.

Figure 2: US Permitting Processes



Once a facility has been constructed, the NSR permit is used as a basis for an inspector to visit the enterprise to verify that the constructed facility conforms to the terms in the NSR permit. As a general matter, once construction is completed, the construction permit continues to govern the facility's operation until an operating permit is issued. The operating permit is typically issued within 12-24 months following completion of construction and includes key terms and conditions from the preconstruction permit that relate to the facility's ongoing operations.

As it continues to operate, a facility may undergo changes. Under the US system, in some cases such changes will trigger the obligation to obtain another construction permit. Once that change is fully constructed, any relevant terms and conditions from the construction permit will then be included in the facility's existing operating permit. This process assures that the facility will be able to continue to upgrade or grow, according to economic needs, while also satisfying air quality obligations.

In the United States, the public engagement process, which relies on transparent, prescriptive, and detailed disclosure and public vetting requirements, helps the regulatory authorities foster accountability and optimize decision-making. Permitting authorities therefore solicit feedback from multiple audiences, including through public education and outreach, translating technical science for lay audiences, and translating documents into the languages of affected communities, among other approaches. Because stakeholders often bring a local vantage point in identifying problems and proposing solutions, public involvement can lead to more robust and informed decisions, simplifying the work of the permitting authority and offering a counterbalance to what may be powerful economic and political interests supporting a project proposal.

4. Affected Sources and Regulated Pollutants

The NSR and Title V permitting programs distinguish between major and minor sources of pollution, and treat criteria, greenhouse gas (GHG), and toxic emissions differently. Figure 1 illustrates these distinctions across facility size, air emissions type, area attainment status, and applicable requirements.

Major sources of criteria pollutants are defined as a source with emissions of PM_{10}, $PM_{2.5}$, NO_X, SO_X, volatile organic compounds (VOCs), CO, or Pb greater than or equal to a threshold of:

- 100 tons per year (tpy), if part of 28 key source categories[13]; or
- 250 tpy, for all other sources not part of the 28 listed source categories.

The emissions thresholds are based on a source's potential to emit (PTE), where PTE is determined on the theoretical basis of a facility being operated 24 hours per day, 365 days per year (8,760 hours/year), with any requisite control technology. The thresholds above apply to new sources in areas where air quality already meets the national standards. In nonattainment areas, the thresholds are lower, generally 100 tpy for all source categories, or lower depending on the severity of air quality (see Table 1).

Table 1: Major Source Thresholds for Nonattainment Areas

Nonattainment Areas			
Pollutant	**Nonattainment Classification**	**Major Source Threshold**	**Offset Ratio**
Ozone *	Marginal (≥ 0.085 < 0.092 ppm)	100 tpy of VOC or NOx	1.1 to 1
	Moderate (≥ 0.092 < 0.107 ppm)	100 tpy of VOC or NOx	1.15 to 1
	Serious (≥ 0.107 < 0.120 ppm)	50 tpy of VOC or NOx	1.2 to 1
	Severe (≥ 0.120 < 0.187 ppm)	25 tpy of VOC or NOx	1.3 to 1
	Extreme (= 0.187 ppm and up)	10 tpy of VOC or NOx	1.5 to 1
Particulate Matter (10µm)**	Moderate	100 tpy	-
	Serious	70 tpy	-
Carbon Monoxide	Moderate (9.1 – 16.4 ppm)	100 tpy	-
	Serious (16.5 and up ppm)	50 tpy	-
Sulfur Dioxide, Nitrogen Oxides and Lead	No nonattainment classifications exist	100 tpy	-

** Nonattainment classifications for the 2008 Ozone NAAQS shown here.*
*** There are no classification design value thresholds (i.e., ranges in parenthesis) for PM_{10} as there are for ozone and CO. All PM_{10} nonattainment areas were originally classified moderate, but an area is supposed to be reclassified to serious if the area does not attain by its attainment date.*

[13] These 28 source categories include primary industry and manufacturing facilities such as iron and steel mills, cement plants, copper smelters, petroleum refineries, etc. For full list see: https://www3.epa.gov/air/tribal/attachmts/NSRBasics110106.ppt.

GHG emissions from the largest stationary sources were covered by preconstruction and operating permitting programs beginning in 2011.[14] The applicability thresholds for major sources are determined for six well-mixed gases (i.e., carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) primarily on the basis of carbon dioxide-equivalency (CO_2e), whereby the mass of each GHG is adjusted for its global warming potential. For new facilities, if the source is subject to preconstruction permitting for another regulated pollutant (i.e., one of the six common air pollutants), then it is also subject to BACT for GHG if the source has a PTE equal to or greater than 75,000 tpy CO_2e.[15] For GHGs, BACT is determined through the same process as for other pollutants, i.e., by the permitting authority on a case-by-case basis which evaluates technologies and techniques, account for energy, environmental, or economic impacts, to establish a numeric emissions limitation for a facility. BACT obligations for GHG emissions are included in the preconstruction and operating permits.

Hazardous air pollutants (HAPs), also known as air toxics, are those pollutants determined through a scientific review process to cause or potentially cause cancer or other serious health effects or adverse environmental effects. There are currently 187 chemicals identified as HAPs,[16] emitted from a wide range of industrial, manufacturing, commercial, and transportation sources. The CAA requires the EPA to regulate these air emissions through the NESHAP program. The NESHAPs are industry-specific standards,[17] with related compliance obligations specified through the operating permit.[18] The EPA groups HAP stationary sources into major and area (minor) source categories, whereby major sources are those that emit 10 tpy of any of the listed air toxics or 25 tpy of a combination of toxics, while area sources are those that emit less than those thresholds.[19] All major sources of HAP emissions, as well as some area source industry categories, are subject to the Title V operating permit program.[20]

Major sources of hazardous air pollutants must meet Maximum Achievable Control Technology (MACT) standards. Updated at regularly established intervals, MACT standards require sources to meet emissions limits equivalent to those already achieved by the best-performing facilities within an industry group. These limits incorporate control technologies, as well as processes, practices, and other methods used by facilities to reduce toxic emissions, and take cost into account. MACT standards apply to both new and existing facilities. New sources must meet an emissions limit no less stringent than that of the best-controlled similar source. Existing facilities must meet an emissions limit no less stringent than the average emissions limit achieved by the best performing 12 percent of existing facilities (or best performing five sources if there are fewer than 30 sources in an industry category).

Area sources of toxic air pollutants, like dry cleaners and gas stations, are typically smaller facilities, which in aggregate can contribute large volumes of emissions in densely populated areas. In order to prioritize across the diverse and numerous sources in urban areas, the EPA identified the 30 air toxics that pose the greatest threat in urban areas and the 70 sources categories that are responsible for 90

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[14] US EPA. (2011, March). *PSD and Title V Permitting Guidance for Greenhouse Gases*. Retrieved from https://www.epa.gov/sites/production/files/2015-12/documents/ghgpermittingguidance.pdf

[15] As a result of a 2014 decision by the US Supreme Court, the EPA is undertaking regulatory changes to establish this limit. Until that time, the EPA has explained that it intends to continue applying the PSD BACT requirement to GHG emissions based on the 75,000 tpy level. The EPA's proposed rulemaking is expected to be published in 2016 for public review and comment.

[16] List of HAPs can be found at: https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications.

[17] NESHAP standards for source categories is available at https://www3.epa.gov/airtoxics/mactfnlalph.html.

[18] NESHAP is not a compliance obligation under the New Source Review program.

[19] Tons per year includes fugitive releases and discharge through vents or stacks.

[20] Information on sources subject to the Title V program can be found online at: https://www.epa.gov/Title-v-operating-permits/who-has-obtain-Title-v-permit.

percent of those 30 air toxics.[21] The 70 source categories of urban area toxic emissions are subject to NESHAP (either MACT or the Generally Available Control Technologies).[22] Title V operating permits typically include terms and conditions for any enterprise subject to NESHAP obligations, whether it is classified as a major source or an area source.

Overview of EU Permitting Programs

EU environmental policy focusses on developing and implementing a clean air policy framework that reinforces national policies for those aspects of air quality that are addressed more effectively or efficiently by pan-European action.[23] The EU's legislation also aims at implementing the Union's international obligations in the field of air pollution, and on integrating environmental protection requirements into, for example, the industry, energy, transport, and agriculture sectors.

The objective of clean air in Europe's 28 Member States is articulated in a series of directives on ambient air quality standards. These directives set limits, or targets, for ambient air concentrations of the main pollutants in order to avoid, prevent, or reduce the harmful effects of air pollutants on human health and the environment, namely:

a) Directive 2008/50/EC on SO_2, NO_2 and NO_X, PM_{10} and $PM_{2.5}$, Pb, C_6H_6, CO, and O_3
b) Directive 2004/107/EC on As, Cd, Hg, Ni, and PAH (including BaP).

Key Legislative Instruments Controlling Air Pollutants

The EU's legislation (collectively known as the "*acquis*") act together to set controls on the main sources of air pollutants. The key legislative instruments on point and mobile sources of air emissions can be summarized as follows:

For stationary sources of non-greenhouse gases:

1. **Directive on Industrial Emissions—**2010/75/EU. Applies to some 55,000 installations in Europe, requiring them to achieve a high level of protection of human health and the environment taken as a whole, in particular through the application of Best Available Techniques (BAT). Permits are required to operate Industrial Emissions Directive (IED) installations and this represents a key mechanism for controlling EU air emissions.

2. **National Emissions Ceilings Directive—**2001/81/EC. In accordance with the EU's Environmental Action Programmes, and in tandem with the Gothenburg Protocol to the UN Convention on Long-range Trans-boundary Air Pollution, the National Emissions Ceilings Directive sets national mass emission limits (allocations) for four key pollutants—sulfur dioxide (SO_2), NOx, non-methane VOCs, and ammonia. Allocations are set at national level and the necessary emissions controls cascade down to contributory sources through the permitting regimes described here.

[21] List of 70 area source categories can be found here: https://www3.epa.gov/ttn/atw/area/70list.pdf
[22] Area and major source rules under NESHAP are listed here: https://www3.epa.gov/ttn/atw/mactfnlalph.html
[23] Member States may supplement these EU initiatives with their own unilateral actions to address their specific national issues.

3. **Petrol Vapor Recovery (PVR I & II).** Directive 94/63/EC (PVR 1)[24] aims to prevent VOC emissions during the storage of petrol at terminals and its subsequent distribution to service stations. Terminals are required to employ measures that reduce evaporative losses from storage tanks. In addition when petrol is loaded onto tankers and transported to service stations the directive ensures that any vapors are recovered and returned to the tanker or terminal. These controls are typically imposed through IED permits.

   Directive 2009/126/EC (PVR II) deals with the recovery of petrol vapor that would otherwise be emitted to air during the refueling of vehicles at service stations. The effective date of controls depends on the service station age and petrol throughput. Member State competent authorities will typically issue permits to impose the directive's requirements, or may establish generally-binding national legislation that obviates permitting.

4. **Paints Directive—**2004/42/EC. This directive sets limits on the VOC content of decorative paints and varnishes and vehicle refinishing products. This is a harmonization directive which aims to ensure the free circulation of goods within the EU's Internal Market. The directive has no direct permitting requirement, but manufacturers of paints and varnishes must label their products to show the VOC content and hence inform customer purchasing practice.

For mobile (i.e., transportation) sources of non-greenhouse gases:

5. **Road transport**. In general, emissions regulations are adopted as part of the EU framework for the type approval of cars, vans trucks, buses, and coaches. The current Euro emissions standards are: Euro 6 for light-duty vehicles (cars and vans) and Euro VI for heavy-duty vehicles. In addition, Directive 2003/17/EC (amending Directive 98/70/EC) establishes standards for automotive fuel quality.

6. **Maritime transport—**Directive 2012/33/EU (amending Directive 1999/32/EC).[25] In compliance with the International Maritime Organisation's MARPOL convention,[26] this directive restricts the maximum permitted sulfur content of marine fuels used in Europe. The directive does not include a permitting requirement and Member States are given the flexibility to effect the controls (e.g., formal notices alerting operators to the controls).

7. **Non-road mobile machinery**. With declining contributions from traditional sources, there is added significance from a variety of combustion engines installed in off-road machines, e.g., garden equipment, construction machinery, rail locomotives, and inland waterway vessels. Emissions from these engines are regulated before they are placed on the market by Directive 97/68/EC (as amended); so there is no permitting requirement.

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[24] Full text of the legislation can be found online at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31994L0063.
[25] Full text of the legislation can be found online at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0033.
[26] Additional information on the International Convention for the Prevention of Pollution from Ships (MARPOL) can be found online at: http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx.

For greenhouse gases:

8. **Emissions Trading System—Directive 2009/29/EC.** The EU emissions trading system (EU ETS) is a central pillar of the European policy to combat climate change. As such, it is a key instrument for delivering Europe's global reduction commitments under the Paris agreement of the United Nations Framework Convention on Climate Change.

   The EU ETS was the world's first major carbon market and remains the largest one. Since its initial formation in 2005, it has evolved to become a key tool for the cost-effective reduction of industrial GHG emissions by giving companies the flexibility to make investments where they deliver the biggest gains.

   The EU ETS works on the 'cap-and-trade' principle on the total amount of certain GHGs (carbon dioxide [$CO_{2]}$, nitrous oxide [N_2O], and perfluorinated compounds [PFCs]). Some 11,000 installations are subject to the scheme–mainly heavy, energy-using installations in the power generation and manufacturing industries, plus certain aircraft operators. The EU ETS applies in 31 countries—the 28 Member States plus Iceland, Liechtenstein, and Norway.

   The overall volume of GHGs that can be emitted each year by participating installations is subject to a cap set at the EU level. Within this Europe-wide cap, companies receive or buy emissions allowances which they can trade if they wish. This cap reduces each year. Caps cover around 45 percent of the EU's GHG emissions.

   Installations covered by the EU ETS are required to have an approved monitoring plan for monitoring and reporting annual emissions. This plan is also part of the operating permit required for industrial installations. Every year, operators must submit an emissions report and surrender an equivalent number of allowances.[27]

   As a well-established scheme, the EU ETS also seeks to assist the development of emissions trading systems in other parts of the world, and to establish linkages to other existing carbon trading schemes[28]—including China.[29]

Main Features of the Industrial Emissions Directive

As a key delivery mechanism in the EU's suite of environmental controls, and by way of illustrating general EU permitting principles, the following text describes the principal features of the IED.

Best Available Techniques: At the heart of the IED is the aim of preventing (and where that is not possible, reducing) emissions from certain industrial activities by the application of BAT. The concept of BAT can be traced back over 30 years in Europe. It originated in Directive 84/360/EEC on the combating of air pollution from industrial plants[30] and provided a core component of Directive 88/609/EEC on the limitation of emissions of certain pollutants into the air from large combustion plants. The concept of

[27] Monitoring, reporting, and verification requirements for the EU ETS can be found online at: http://ec.europa.eu/clima/policies/ets/monitoring/index_en.htm.
[28] See: http://ec.europa.eu/clima/policies/ets/markets/index_en.htm
[29] See: http://ec.europa.eu/clima/news/artides/news_2016062801_en.htm
[30] Where it was originally known as BATNEEC--'best available technology not entailing excessive cost.'

BAT further evolved in Directive 1996/61/EC (concerning integrated pollution prevention and control [IPPC]) and became a central pillar when IPPC was consolidated into Directive 2010/75/EU on IED.

According to the IED, "best available techniques" means:

> *"… the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:*
>
> *(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;*
>
> *(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;*
>
> *(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole."*

Since the 1996 IPPC Directive, BAT has been identified at the EU level for some 30 industrial sectors using a series of "information exchanges" among Member States, the industry concerned, and environmental NGOs. A specially convened Technical Working Group undertakes an objective and consensual evaluation of environmental performance data to determine the BAT for a sector and the expected performance level that can be achieved (so-called BAT-Associated Emission Levels or BAT-AELs). These "BAT conclusions" are recorded in legally binding Commission Implementing Decisions[31] which operators and Member State competent authorities have four years to effect. Fuller (non-binding) records of these information exchanges are captured in BAT Reference Documents (BREFs), which give a more detailed understanding of how BAT was derived.[32]

Not only has Europe applied BAT principles for over three decades to prevent and minimize emissions from industrial sources, but it is now widely considered a key mechanism to be applied to large point sources under several international laws, e.g., UN Economic Commission for Europe (UNECE) Protocols on acidification, eutrophication and ground-level ozone (Gothenburg); heavy metals (Aarhus); and mercury (Minamata).

Holistic Approach: Permits issued under the IED must include conditions to prevent and control all environmental impacts from an installation taking into account its full environmental performance, i.e., emissions to air, water, and land; generation of waste; use of raw materials; energy efficiency; noise; prevention of accidents; odors; and restoration of the site upon closure.

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[31] BAT conclusions are available online at: http://ec.europa.eu/environment/industry/stationary/ied/implementation.htm.

[32] Reference documents under the IPPC Directive and the IED as generated through the exchange of information process can be found online at: http://eippcb.jrc.ec.europa.eu/reference/.

Such an integrated system is considered to be more efficient, as the same permitting procedure takes account of the effects of industrial activities on the three main environmental media (air, water, and land), and therefore may provide opportunities to optimize decision-making across media effects.

In practice, this means that the choice of the best air abatement technique would take into account the ease of treating any resulting wastewaters (e.g., from a wet scrubber) and treating or disposing of any solid waste residues (e.g., spent catalyst from VOC oxidation). There is no single agreed upon method for determining the best environmental option, although various structured approaches are described in the "Economics and Cross Media" BREF.[33]

Scope: The industrial activities covered by the IED are defined in its Annex I. They are divided into the following main sectors: energy industries, metal production and processing, mineral industry, chemical industry, waste management, and a grouping of unrelated activities (including intensive livestock farming, pulp and paper, food and drink production). The "energy industries" sector includes the combustion of fuels in installations with a total rated thermal input of $\geqslant$50 MW—so called Large Combustion Plant (LCP).

Minimum Standards: For some industrial sectors, including LCP and waste incineration, the IED sets emissions limit values which act as a back-stop on minimum acceptable performance, below which EU industry may not operate.

Implementation: The primary responsibility for implementation of the IED rests with the government of each Member State. In turn, these governments will assign competent authorities to deliver practical implementation of the directive. In the UK, by way of example, the competent authorities are the Environment Agencies in the four component parts of the country, i.e., England, Scotland, Wales, and Northern Ireland. These four agencies are empowered by legislation that transposes the IED into national law.

Enforcement and Compliance: The IED requires Member States to take the necessary measures to ensure that the permit conditions are complied with by operators. In the event of a breach of permit conditions, Member States have to ensure that:

(a) the operator immediately informs the competent authority;
(b) the operator immediately takes the measures necessary to ensure that compliance is restored within the shortest possible time;
(c) the competent authority requires the operator to take any appropriate complementary measures that the competent authority considers necessary to restore compliance.

In extreme situations, operation of the activity has to be suspended if the breach of the permit conditions poses an immediate danger to human health or threatens to cause an immediate significant adverse effect upon the environment. These strong enforcement provisions are seen as essential for upholding the inviolability of BAT.

Predicted Benefits: In view of ongoing implementation of the IED, its full benefits are yet to materialize. However, an *ex-ante* assessment of the costs and benefits of stricter BAT-based minimum measures for LCP showed a very significant potential for emissions reduction and, when compared to 2004, the

[33] The BREFs for Economics and Cross Media are Retrieved from http://eippcb.jrc.ec.europa.eu/reference/ecm.html.

emissions of SO_2 and NOx would be reduced between 60 percent and 87 percent and between 80 percent and 97 percent, respectively.[34] By far the largest reductions were anticipated at coal- and lignite-fired plants. In addition, the monetized health impacts in 2020 resulting from these emission reductions were assessed. This showed that implementing the BAT scenarios would bring significant additional benefits, compared to the baseline under the National Projections scenario. In 2020, these benefits may be around €9–30 billion per year. The benefits of reduced impacts on ecosystems were not quantified.

Part II: Key Questions & Answers on International Experience with Air Emissions Permitting

Q #1: What's the relationship between an environmental impact assessment and a preconstruction permit?

Under the preconstruction permitting framework of the NSR in the United States, each new source or major modification to an existing source is subject to review by a state or local permitting authority (with EPA oversight). That review assesses the proposed impact of the new activities using dispersion modeling to evaluate the impact of the new emissions on the surrounding air quality, in light of the NAAQS. In the case of permitting in nonattainment areas, such an analysis may be used to identify the quantity of "offsets" required in order for the source or major modification to be constructed. In the case of permitting in attainment areas, the analysis may be used to determine if projected emissions will cause pollution in excess of air quality "increment," i.e., the maximum allowable increase in a pollutant concentration. There are also other types of analyses that are also part of the preconstruction permitting, including considerations regarding visibility in certain "Class I" areas. The focus of these analyses is on the relationship between the new emissions that are expected from this project and the existing air quality status of the area. Thus, this is not intended to be a holistic "environmental" impact assessment.

This type of analysis is different from, and separate from, an "environmental assessment" or "environmental impact statement" that might be required under a separate federal law in the United States–the National Environmental Policy Act (NEPA). NEPA is not typically invoked in the US permitting process. Rather, NEPA typically applies to other, different types of actions (one example may be highway construction by a federal agency). NEPA is similar in some respects to the Chinese Environmental Impact Assessment Law. The US NEPA requires federal agencies to prepare a detailed, multi-disciplinary assessment of the environmental impacts of certain major federal actions.[35] In that NEPA assessments are intended to inform decisions made under other federal statutes, it represents a procedural obligation. In other words, mere completion of the analysis satisfies the statutory obligation in many cases. This type of analysis is not required for preconstruction or operating permits under the CAA. The NSR preconstruction review process, in contrast, involves prescriptive and substantive requirements, most of which are directly related to air quality. This is an important distinction between NEPA assessments and NSR.

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[34] Evaluation of the costs and benefits of the implementation of the IPPC Directive on LCP, prepared for the European Commission DG ENV.C.5, 2007, Retrieved from https://circabc.europa.eu/w/browse/5da81344-24b4-495b-a220-769dfae8abc1.
[35] US NEPA information is Retrieved from https://www.epa.gov/nepa/what-national-environmental-policy-act.

Preconstruction permitting primarily serves as a tool for attaining and maintaining the ambient air quality standards. However, there is flexibility built into both the emissions limit determination process and the process for public participation that allows permitting agencies to take local considerations into account beyond air quality. For example, the CAA provides that "energy, environmental, and economic impacts and other costs" be factored into BACT determinations. Additionally, while the NSR sets out specific conditions that must be met for a permit to be issued, meeting those conditions does not guarantee a company that a permit will be issued. The permitting authority has discretion to reject an application, require alternatives–which may include variations on equipment configuration, alternative facility siting, or no project at all–and in some cases impose more stringent requirements than the minimum requirements outlined by the CAA.[36] By conferring the authority to consider environmental impacts more generally, the permitting process can also be an effective tool to optimize decision-making and respond to local health risks and other circumstances.

Q #2: How does a permit drive technology adoption at the facility level?

In the United States, permits serve to capture all applicable requirements and do not generally set new requirements. While technology considerations are part of the preconstruction permitting process (e.g., in determining BACT and LAER), it is in setting the NSPS and NESHAPs that technology considerations are more directly taken into account.

The CAA authorizes the EPA to develop technology-based standards which apply to specific categories of stationary sources. These are the NSPS, which apply to new and modified sources. EPA updates the NSPS by conducting a technology review to assess the emissions performance achieved through adequately demonstrated, commercially available technologies in a given sector.[37] This includes surveying the manufacturers of the equipment to assess if there is adequate capacity (in terms of the equipment itself and available labor to install it) to deploy the technologies within the expected compliance timeframe. While these standards are based on the effectiveness of one or more specific technological systems of emissions control, the EPA does not prescribe a particular technological system. Rather, sources have flexibility to elect whatever combination of measures will achieve equivalent or greater control of emissions. NSPS represent the minimum level of stringency that a state permitting authority can consider for BACT.

The NESHAP program, described earlier, similarly involves regularly updating technology-based standards for sources of air toxics through surveying industry practices and performance.

Technology review is used in determining BACT and LAER as part of the permitting process, as described earlier. In brief, the regulatory agency surveys emission control technologies and techniques (i.e., pollution prevention measures, source substitution, etc.) that have been demonstrated in practice to reduce pollution, ranks them according to control-effectiveness, and evaluates economic, environmental, energy and other considerations (see Part I). The preconstruction permitting process is case-by-case. Even where consistent technologies are used across a particular sector, the permits for

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[36] Foote, G. (2004). *Considering Alternatives: The Case for Limiting CO_2 Emissions from New Power Plants Through New Source Review*. CIEL. Retrieved from http://www.ciel.org/reports/considering-alternatives-the-case-for-limiting-co2-emissions-from-new-power-plants-through-new-source-review-may-2004-foote-2/

[37] NSPS are based on the Best Demonstrated Technology. This refers to the best system of continuous emissions reduction that has been demonstrated to work in a given industry, considering economic costs and other factors. The NSPS take a variety of formats depending on the source category. The standard can be a numerical emissions limit, a design standard, an equipment standard, or a work practice standard.

these sources will include requirements based on the specific operations of each source. This is important because a particular technology may perform better or worse at one affected source then at another location, based on characteristics unique to that source.

Whether NSPS, NESHAPs, or BACT/LAER, the emissions standards themselves do not require that the affected sources install the same technologies that the regulatory agency assessed when it developed the emissions standards. In preconstruction permitting, the regulations requires compliance with specific emissions limits, and affected sources can choose whatever technologies or techniques they wish in order to demonstrate compliance with the limits. The sources are not bound to a certain catalog of technologies, although in some cases, such as NO_X reductions from a power plant, there are limited options available to achieve a BACT or LAER emissions level. By specifying that the affected sources must meet an emissions limit rather than specify a particular technology or technique, the regulatory agency avoids picking "winners and losers," i.e., avoids advocating the products of specific companies or particular technologies.

Affected sources can also use a combination of technologies and techniques to comply with emission limits. A power plant could undertake projects to improve the heat rate (i.e., generate the same or greater quantity of electricity using less fuel), switch to a fuel with a higher heating value, and also install emission controls. In practice, for many capital-intensive industries, such as iron/steel, cement, and power generation, once a particular technology has been well demonstrated, other facilities tend to install the same technologies rather than risk investing significant money into technologies that may be less expensive but which have not been demonstrated to work. For other industries, particularly those which use or emit VOCs, there is a much broader range of choices available to meet emissions standards, such as product re-design (to use fewer or less hazardous compounds), application equipment (electrostatic spraying to avoid VOC emissions) or emissions control equipment (to capture fugitive emissions and destroy emissions through incineration).

Emissions standards are set based upon the assumption that the technologies and techniques will be installed and that the equipment or techniques will work. Each permit will include conditions to ensure that whatever technologies and techniques are chosen by the enterprise, it will continuously comply with applicable emissions limits.

Examples of permit conditions which influence technology selection at the facility-level may include:

- Expression of applicable regulatory emission limits, e.g., national, regional, or local sector-based requirements (i.e., power plants, iron/steel, cement, etc.);
- Expression of BACT and LAER determinations made by the permitting authority (the case-by-case decisions made for new or expanded activities);
- Expression of NSPS and NESHAP/MACT requirements applicable to existing activities;
- Variables related to the operation of the emissions control equipment. These are derived from manufacturer's specifications, and the warranty or certification provided by the manufacturer to the enterprise. Typical variables include terms related to operating ranges for temperature, pressure, and flue gas volumes, periodic maintenance, and troubleshooting steps to take if the equipment is not operating properly. These terms also help to ensure that the emissions control equipment operates at its design effectiveness for its entire projected life;

- Variables related to manufacturing and product production. Examples include identification and quantities of materials used, and materials handling techniques (i.e., to avoid fugitive releases of dust or hazardous air pollutants, and good housekeeping practices);
- Existing air quality in the area where the facility is located.

Q #3: What is the link between the permit and monitoring, recordkeeping, and reporting for compliance?

Permitting is an important element of the air quality management process, a key instrument for implementing control strategies at stationary sources (see Figure 3).[38] Monitoring, recordkeeping, and reporting are fundamental aspects of the permit as a tool for implementation.

Permitting requirements and procedures can be designed to facilitate compliance and enforcement by requiring enterprises to monitor operating conditions, maintain equipment within specified ranges and precision, maintain detailed records, make records available for inspectors, and regularly report data to the permitting authority. The obligations for monitoring, recordkeeping, and reporting must be sufficient to determine when the facility is and is not in compliance with all regulatory requirements and emissions limits.

Figure 3: Permitting as a Key Component of Air Quality Management[39]

When Congress revised the CAA in 1990 to add the operating permits, a primary consideration at the time was assuring compliance with applicable requirements through adequate monitoring,

[38] Under the CAA, preconstruction NSR permitting is part of a state's SIP while the Title V operating permits are not part of the SIP and are thus not a "Title I" control strategy for attaining/maintaining NAAQS.
[39] US EPA Air Quality Management Cycle Retrieved from https://www.epa.gov/air-quality-management-process/air-quality-management-process-cycle.

recordkeeping, and reporting. Compliance assurance monitoring (CAM) is intended to provide a reasonable assurance of compliance with applicable requirements under the CAA for large emissions units that rely on pollution control device equipment to achieve compliance.[40] Monitoring is conducted to determine that control measures, once installed or otherwise employed, are properly operated and maintained so that they continue to achieve a level of control that complies with applicable requirements. The CAM approach establishes monitoring for the purpose of:

1) Documenting continued operation of the control measures within ranges of specified indicators of performance (such as emissions, control device parameters, and process parameters) that are designed to provide a reasonable assurance of compliance with applicable requirements;
2) Indicating any excursions from these ranges; and
3) Responding to the data so that the cause or causes of the excursions are corrected.

Monitoring in particular must be appropriately related to the emissions limit. In some cases, permits and regulations may reflect what is commonly referred to as "parametric" monitoring, i.e., measurements of certain operational parameters that correspond to process or control device (and capture system) efficiencies or emissions rates.

Continuous emission monitoring systems (CEMS) help to assure compliance by providing all emissions data–highs and lows–even if the emissions limit is based on a 30-day rolling average. Continuous monitoring can be paired with automated compliance incentives and enforcement penalties. In the case of fossil-fuel power plants with continuous emission monitoring, the facility conducts initial certification tests and on-going quality assurance testing on emissions monitoring systems to ensure data quality (i.e., accuracy, reliability, consistency). These tests include, for example:

- Daily monitoring system calibrations and interference checks;
- Quarterly monitoring system linearities, leak checks, flow-to-load tests;
- Bi-annual or annual monitoring system relative accuracy tests and bias tests.

Emissions system quality assurance tests require the presence of a 'qualified individual' with specific knowledge and certification from an industry training body; environment agency staff are invited to observe quality assurance tests. EPA and state environmental auditors also visit emissions sources to conduct on-site audits, reviewing the monitoring system(s) and the measurement operations, maintenance, and quality assurance procedures.

In US programs, monitoring, recordkeeping, and reporting specifications are independently enforceable obligations. Self-reporting is a key aspect to compliance assurance, because it creates individual accountability for emissions at the facility level. For example, EPA reporting requirements stipulate that operational data reports be certified and submitted by senior company officials and must include a certification statement that confirms the senior official:

1) Has personally examined the report and confirmed data with relevant expert staff;
2) Certifies data are true, accurate, and complete; and
3) Is aware that false data or statements can lead to fines and/or imprisonment.

[40] Compliance Assurance Monitoring rule and technical guidance Retrieved from https://cfpub.epa.gov/oarweb/mkb/cam.cfm

Compliance can also be improved by involving the owner/operator directly in the permit drafting and in the preparation of related information. If the official is *personally* liable for certifying the information, this can provide accountability and integrity in the information. It can also help to ensure that the regulated entity is engaged and committed to the decision-making process and fully understands the monitoring, recordkeeping, and reporting requirements. Using the enterprise's experience and knowledge can facilitate compliance, while reducing the administrative burden on the permitting authority.

Q #4: How does the permit support data collection and management?

Data gathered through the monitoring, recordkeeping, and reporting provisions of a facility's operating permit are used to assess compliance with the permit and provide the basis for enforcement actions. This data can also be used to improve the quality and accuracy of emissions inventories, and serve as a cross-check for ambient air quality data. In the United States, however, it is typically other federal or state regulations that provide for emissions data collection.

Systems for data collection and management used by the EPA and environmental authorities at the state, local, and tribal levels in the United States have developed over the course of more than four decades of implementing environmental programs. Many of these environmental programs have been developed ad hoc, under different statutes to address different environmental problems —e.g., those used in regulating GHGs, toxics, and specific source categories. Air emissions information is currently collected by the EPA, state, or local air agencies through various separate regulations, in a variety of formats, according to different reporting schedules, that use multiple routes of data transfer. For example, enterprises are required to report their attributes separately for the following programs:

- Greenhouse Gas Reporting Program,
- Toxics Release Inventory,
- National Emissions Inventory via state air agencies, and
- Compliance reporting requirements for 40 CFR Part 60 and Part 63 regulations, known as Compliance and Emissions Data Reporting Interface, which require affected sources to perform emissions performance tests, conduct continuous emissions monitoring, and submit compliance and emissions report.

Some of the information is sent directly to the EPA by regulated entities (e.g., compliance data for the EPA's SO_2 and NO_X programs for power plants and industrial boilers), while other information is sent by the regulated entity to a state or local air agency that uses it for its own purposes before sending nationally required information on to the EPA (e.g., compliance data for Title V operating permit programs). Quality assurance and quality control (QA/QC) may be done by the local agencies and by EPA.

A benefit of designing and implementing various environmental management programs concurrently would be to integrate and streamline platforms and procedures for data collection. Doing so today would additionally afford the advantage of using applications of networked and automated information technologies to reduce regulatory burdens and improving efficiency and transparency.

One example of data collection overseen directly by the EPA which utilizes automated data management is compliance reporting for the SO_2 and NO_X cap-and-trade programs. The EPA collects continuous emissions monitoring and related operational data according to very detailed specifications because accurate emissions monitoring and accounting provide the backbone of these nationally-administered regulatory programs.[41] More than 4,000 coal, gas, and oil-fired electric generating units report emissions and related information directly to the EPA, including:

- A facility's monitoring plan, which provides details on monitoring methods, technologies, configuration, and operational specifications of monitoring equipment and related information specific to the unit;
- The results of quality assurance tests performed on the measurement systems used on-site;
- Hourly CO_2, NO_X, SO_2, and mercury concentrations and emissions flow;
- Hourly energy input, electric output, and other operational data.

The EPA uses this information to develop an accurate record of hourly emissions for every operating hour at every power plant subject to the program. In addition to assessing compliance with emissions trading programs, this data record is used for a number of different purposes, such as: supporting enforcement actions where power plants fail to comply; conducting air quality modeling studies; doing cost-benefit analyses of proposed regulations; and undertaking policy research and development for future interventions.[42]

The initial quality assurance (QA) efforts are undertaken by the power plant owner/operator itself, which conducts initial certification tests and on-going quality assurance testing on emissions monitoring systems to ensure data quality (i.e., accuracy, reliability, consistency). The facility stores continuously measured information locally in a data acquisition and handling system, and at the end of each quarter transfers that data to EPA software.[43] Using the EPA software, the power plant conducts an electronic audit of the data. If data passes the electronic audit, a senior company official or his or her agent personally self-audits and certifies the data before submitting it to the EPA. The EPA then reviews electronic audit results and conducts additional statistical analyses of data. The EPA and state environmental auditors also visit emissions sources to conduct on-site audits, reviewing the monitoring system(s) and a facility's measurement operations, maintenance, and quality assurance procedures. These monitoring and data reporting provisions would typically be included in the terms and conditions of a facility's operating permit.

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[41] The EPA's emissions measurement and reporting regulation (40CFR Part 75; known as the Part 75 Rule) was originally published in 1993. More information is available at https://www.epa.gov/airmarkets/emissions-monitoring; also see EPA. (2009). *Plain English Guide to the Part 75 Rule.* Retrieved from https://www.epa.gov/sites/production/files/2015-05/documents/plain_english_guide_to_the_part_75_rule.pdf

[42] Analyzing ozone air quality impacts from low-utilization power plants in the Northeastern United States provides an example of how this data record may be used in policy research and development. In this case, hourly emissions data were combined with hourly ambient ozone concentrations, hourly temperature, and hourly electricity demand to assess the impact on ozone levels of uncontrolled peaking power plants. These are power plants that only operate during periods of high electricity demand, i.e., during high-temperature days when electricity demand increases to meet demands for air conditioning, and which typically do not have pollution control equipment installed. The study identified potential contributors to the ozone problem and recommended a set of policies and incentives (e.g., demand-side management and energy efficiency) to address the ozone issue.

[43] The EPA provides free electronic auditing and reporting software (Emission Collection and Monitoring Plan System) that emissions sources must use to report emissions data to the EPA. After the data are imported to the software, the software conducts hundreds of audit checks on monitoring plans, QA test results, and emissions and operations data. US EPA. (2015). *Emissions Collection and Monitoring Plan System (ECMPS) Reporting Instructions Monitoring Plan*. Retrieved from https://www.epa.gov/sites/production/files/2015-11/documents/ecmpsmpri2015q3_0.pdf

Q #5: What is the process surrounding renewal and revisions?

In the United States, the process of renewal and revisions are different for preconstruction and operating permits. This section focuses on Title V operating permits.

The CAA provides that an operating permit will expire after five years of its date of issue unless renewed prior to expiration. Renewal involves the same review process as for initial applications, described earlier in the Overview section, including public participation and the opportunity for public hearings,[44] state and EPA review. These procedures, like those to process a new construction or operating permit, follow a consistent schedule and are clear, transparent, and publicly available.

Operating permits may also be revised based on changes in activities or processes at the enterprise, or to incorporate new or updated regulatory or policy requirements. Plant owner/operators are required to report changes to the facility, such as changes to plant ownership and any equipment modifications that may or may not influence facility emissions. Permits must be revised to reflect those changes according to procedural requirements that vary with the degree of impact that the revisions will have on emissions and related monitoring, recordkeeping, and other operational details specified in the permit. Minor and administrative revisions require less processing, while revisions that impact emissions require more analysis. Significant permit revisions are subject to EPA review procedures and public participation, including the opportunity for a public hearing. Reissuance due to a permit revision does not extend the five-year life of the permit.

Preconstruction permits terminate after a period of time if construction is not commenced and continued in a particular manner. Most preconstruction permits will expire after 18 months.

Q #6: How do permits reflect emissions trading requirements?

In the US context, operating permits aggregate all applicable obligations borne by a facility, including those pertaining to compliance with an emissions trading program. Thus, permits would include the terms necessary to enforce the obligations associated with the trading program. For example, a permit may include an obligation to either reduce emissions below a certain amount, or obtain credits to allow the source to emit above a certain amount. The specific details of the trading program would inform the permit terms.

Emissions trading systems are regional or national in scale; some are administered by the EPA, others by states. As a result these programs may be reflected in permits in different ways. In the case of federally administered programs, like the acid rain and NO_X budget programs, the terms and conditions are incorporated in Title V operating permits. In the case of state administered programs, such as the Regional Greenhouse Gas Initiative (RGGI) established by nine states in the Northeastern United States to reduce CO_2 emissions from the power sector, states may decide to align related obligations with the existing operating permits program.

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[44] Public hearings are open door sessions when the public in invited to present its message to government authority face-to-face; the agency is generally in listening mode, although hearings may present opportunities for officials to explain aspects that are not clearly understood by some members of the public. Official transcripts of the hearings are entered into the public record and evaluated alongside public comments submitted via paper, fax, email, or other electronic format.

The NO_X budget program illustrates the emissions budget-setting process and how related obligations fit into the permitting process. In the case of that program, the EPA completed modeling to assess the degree of overall emissions reduction required to minimize the effects of ozone precursors (NO_X) in the Eastern United States, which had impeded those states' ability to meet the ambient air quality standard for ozone. The EPA then apportioned the overall budget to affected states based on average electricity generation rates over an annual time period. States were then responsible for allocating specific emissions targets to the affected electricity generating units in their state (generating units larger than 25 megawatts (MW) in capacity).[45]

The NO_X budget program (as well as SO_2 trading under the acid rain program and CO_2 trading under RGGI) require enterprises larger than 25 MW to install, operate and maintain CEMS, and to report CEMS data each quarter to the state and to the EPA. States and the EPA perform QA/QC checks on the CEMS data and, once verified, data are uploaded to state and EPA databases and made publicly available. While RGGI is a state-based emissions trading program, RGGI uses the identical CEMS and QA/QC procedures as those required in the EPA-administered acid rain and NO_X budget programs, as described earlier under Question #4.

As with other regulatory programs, the emissions limits related to emissions trading programs and the monitoring, recordkeeping, and reporting requirements are inserted into the individual permits of the affected enterprises.

Q #7: How can a permit system be designed to address multiple pollutants and capture trade-offs between water, air, and solid waste control?

Principles of Integrated Planning

Permits can address multiple pollutants and different media in different ways. One method is a unit-by-unit approach. In this approach, the permit could describe all the requirements that apply to that unit or process for all media (e.g., air, water, solid waste, energy consumption, etc.). Another approach is that the permit could include different sections organized by media wherein each section includes all of the emissions units/processes and the relevant obligations for that media (e.g., all the air emissions units are covered in the air section; water units in the water section; etc.). Yet another way might be to organize the permit by pollutant-specific restrictions–for example, identify all the NOx limits from all units for all media in one section, and so forth. These are just a handful of ideas and there are likely other ways as well. Each method may have different benefits in the way obligations are characterized and enforced. In the United States, due in large part to the way in which the environmental laws were enacted by Congress, permitting tends to be single media (i.e., separate Clean Air Act permit from Clean Water Act permit).

Research indicates that integrated multiple pollutant models for air quality management, which encourage consideration of related and sometimes conflicting air quality, energy, climate change, land-use, and transportation priorities, can be more cost-effective and less administratively burdensome for both regulated entities and the agencies that regulate them. The EPA's Clean Air Science Advisory

[45] Note that states were also granted the flexibility to set aside a portion of their state emissions budget for new sources, or for renewable energy and energy efficiency programs. Typically, this set-aside comprises one to five percent of the total state emissions allocation. The effect of any set-aside is to slightly increase the overall stringency of the program, since slightly fewer allowances are available to the affected enterprises.

Committee recommends that agencies approach pollution issues holistically, and implement solutions that jointly address multiple pollutants and media (or at a minimum, do not result in adverse trade-offs between different pollutants and media). However, putting multi-pollutant and multi-media models of environmental management into practice can be challenging. They require strong interagency and inter-jurisdictional cooperation, a high level of trust between business and government, as well as strong technical understanding across pollutants, media, and pollution sources.

The terms multi-pollutant and multi-media are frequently used, but what do these terms really mean? Some agencies highlight "multi-pollutant" approaches that synchronize the installation of NO_X and SO_2 controls. While this can be more cost-effective and help to reduce pollution, this type of "multi-pollutant" approach is consistent with traditional end-of-pipe emissions controls, but with an emphasis on installing multiple controls at the same time.

One way to more fully achieve the economic advantages and the environmental objectives of multi-pollutant and multi-media programs is to undertake an integrated planning exercise that evaluates costs and benefits of different energy and environmental options. A general step-wise approach for doing such an integrated planning exercise for air quality management would adhere to the following principles:

- Determine acceptable level of morbidity and mortality from pollution sources;
- Determine pollutant concentrations and reductions required to reach this goal;
- Convene technical and policy staff from environmental, energy, and economic agencies at a interjurisdictional level relevant to the current and future scope of the problem;
- Establish planning procedures that evaluate options on the basis of environmental and energy objectives, including demand-side measures (e.g., energy efficiency measures, distributed photovoltaic solar power, commuter rail, etc.) and supply-side measures (e.g., conventional power generation with pollution controls, wind power, etc.);
- Identify near-, medium-, and long-term objectives and constraints, and areas where cooperation could improve the timing and efficacy of control measures;
- Rank order results by cost-effectiveness, efficacy, and ability to avoid cross-media and pollutant transfers;
- Ensure that modeling exercises transparently disclose key variables and communicate results.[46]

One way to apply these principles to permitting would be for the permitting authority to determine the "best available techniques and technologies" based on maximizing useful output while minimizing overall emissions across media and pollutants, both direct and indirect emissions. In permit terms, this could mean adopting an output-based emissions limit, i.e., kilogram of pollutant emissions (to air or to combined media) per ton of cement or megawatt-hour of electricity, rather than grams per joule of fuel consumed. Such an approach would seek opportunities to reduce pollutant emissions throughout the facility. Use of products that might otherwise be disposed of as waste, or implementing end-use electric energy efficiency programs in buildings and residences could be counted as part of the overall system of manufacturing products or meeting demand for electricity.

[46] A strong example of integrated planning is provided by the Northwest Power and Conservation Council, an interstate agency established by the US Northwestern states of Idaho, Montana, Oregon, and Washington to oversee regional planning to balance energy and environmental objectives at least-cost. Its seventh power plan can be found online at: http://www.nwcouncil.org/energy/powerplan/7/plan/.

Another approach to applying multi-pollutant principles to permitting might start by examining the confluence of pollution risks across populations potentially affected by a proposed facility, then evaluating the additional burden that the emissions of the facility would pose to affected populations. Emissions limits determined through the permitting process could seek to achieve an acceptable level of risk. A facility with emissions that would impact higher-risk populations would face greater stringency. Alternatively, an offset mechanism could be used, something akin to that used in the preconstruction permit program in nonattainment areas in the United States. This could take into account the multi-pollutant or multi-media attributes of the offset to recognize a higher value for an offset that imparts multi-pollutant/multi-media benefits.

Historical Context of Single- vs. Multi-Media Approaches in the United States and European Union

Enterprise activities involve the discharge of pollutants to air, water, and waste media, and environmental health and safety personnel at such facilities also generally focus on processes and their effects across all media. However, environmental statutes and regulations historically have been enacted and effectuated along specific media lines. This has been the case in both the European Union and United States. Today however, the United States largely retains a focus on single-pollutant control strategies, while the European Union has evolved to incorporate approaches that reflect multi-pollutant and multi-media considerations.

The US Congress enacted the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act, each of which focuses on specific media. Environmental agencies, in turn, have adopted media-specific regulations to implement the various laws, which also follow media-specific paths, e.g., air and water quality permits, and hazardous waste discharge permits. With regard to permitting specifically, the Clean Air Act, especially the 1977 and 1990 Amendments, in practice represents a command and control approach focused on prescribing control technologies to reduce an individual pollutant at each emissions point.

However, there have been successful policy efforts to employ cross-media strategies in the United States. A few states have piloted multi-media permitting approaches. For example, Washington passed legislation in 1995 to encourage coordinated permits covering all media.[47] At the federal level, the Pollution Prevention Act of 1990 required the EPA to establish source reduction techniques across all media, and required enterprises to submit an annual report (called “toxic chemical release form”) to the EPA that described the pollutants discharged and what techniques were used to reduce such discharges.[48] The EPA has also worked to align rulemakings to optimize multi-pollutant reductions; for example, regulations for cement manufacturing enable affected enterprises to comply with criteria pollutants and HAPs, resulting in significant cost savings to industry.[49]

Europe’s approach has changed over time. Early legislation, such as the UK Clean Air Act of 1956, also focused on individual media. However, informed by a 1976 report by the Royal Commission on

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[47] Washington State Legislature, RCW 70.95C.250, Multimedia Permit Pilot Program. Retrieved from http://app.leg.wa.gov/rcw/default.aspx?cite=70.95C.250

[48] US Pollution Prevention Act of 1990. Retrieved from http://www.epw.senate.gov/PPA90.pdf

[49] Witosky, M. (2010). *Sector-Based Multipollutant Approaches for Stationary Sources*. Presentation to Clean Air Act Advisory Committee, Washington, D.C. Retrieved from http://www.eli.org/sites/default/files/docs/seminars/10.20.10dc/EPA-Attachment-1.pdf?q=pdf/seminars/10.20.10dc/EPA-Attachment-1.pdf

Environmental Pollution,[50] England moved first towards a multi-pollutant framework for permitting. In 1990, the UK passed the Environmental Protection Act. This Act consolidated several previous laws, recognized the significant changes that had occurred to improve the environment over the previous decade, and focused programs on prevention ("root-of-pipe") rather than cure ("end-of-pipe").[51]

Similarly, European permitting began with a separate focus on air and water quality, but has evolved into a multi-media system. The European Union has adopted directives for specific air pollutants, but application of the various air, water, and solid waste standards and requirements occurs through other directives such as the Large Combustion Directive[52] and the Integrated Pollution Prevention Directive,[53] both of which require BAT to be used to meet multi-media environmental standards. Individual countries' legislation may continue to follow a media-specific path, but the scope of such legislation increasingly reflects the role and primacy of the multi-media EU Directives.

In practice, multi-media permitting through the EU directives establishes a range of emissions limits to satisfy BAT and affords a significant degree of discretion to individual Member States as to how BAT is applied. On a case-by-case consideration of enterprises, less wealthy Member States may be given extra time to implement BAT or may implement BAT at the higher end of an emissions range. Oversight by the European Commission is focused on air quality plans and meeting overall emissions targets, as set forth by the Commission. But the plans must be implemented though legislation in each Member State, and the European Commission does not have veto authority over individual permits.

Both the US and EU systems emphasize consistent enforcement and compliance, and provide strong oversight roles for the EPA and the Environment Departments in each EU Member State. In the United States, states are the lead agencies to implement and enforce air quality permits, but the EPA has the authority to veto specific operating permits and issue a federal operating permit in certain circumstances. In the US system, BACT and LAER apply nationally for sources subject to construction permits and no exemptions are provided for local economic circumstances. This largely eliminates a potential for competitive advantage, since there is no incentive for a source to build or expand in one state vs. another on the basis of regulatory stringency (though other factors, i.e., tax benefits, subsidies, lower labor costs, etc., may encourage relocations).

In Europe, Directives and emissions targets are established at the European Union level (EU 28). Each Member State then implements these directives and targets by passing legislation, adopting regulations, and enforcing them. Member States can utilize flexibility provisions written into directives to delay the effective date of a directive or target based on particular economic considerations, but must ultimately meet the same requirements as all other Member States. In part owing to the lack of central oversight in permitting, there is not a consistent understanding of how multi-pollutant and multi-media provisions have been implemented across Member States.

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[50] Royal Commission on Environmental Pollution. (1976). *Air Pollution Control: An Integrated Approach.* RCEP 5th Report. Retrieved from http://www.rcep.org.uk/reports/05-air/1976-05air.pdf

[51] RCEP. (1992). *Best Practicable Environmental Option*. 12th Report. Retrieved from http://www.rcep.org.uk/reports/12-bpeo/12-response.pdf

[52] Large Combustion Plant Directive. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3Al28028 (This Directive is in the process of being revised and updated as of February 2016.)

[53] Industrial Emissions Directive. Retrieved from http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

Part III: The Resources and Technical Capacities Required for Implementation

Case Studies of US Air Permitting Programs

In the United States, air quality permits are issued by agencies in all 50 states, 116 municipal or county level agencies, and four US territories.[54] Several different types of permits are issued, including construction permits, operating permits, Title V operating permits, and general permits, and permits are issued for both major and minor sources. This section provides the administrative details of permitting programs run by state and county level agencies in areas that represent a cross-section of jurisdictions with urban population and industrial characteristics that make them potentially more relevant to the Chinese experience.

Each jurisdiction described here has a significant, and in some cases concentrated, industrial presence. The city of Pittsburgh, and the states of Illinois, Pennsylvania, and Virginia have many coal-fired power plants and large industrial enterprises (production of cement, steel, pulp, and paper). The Seattle metro area, for example, has several aircraft manufacturing plants (Boeing), many high tech industries (Microsoft, Amazon, Google, Oracle) and is one of the ten largest port facilities in the United States. Maryland has a mix of enterprises, with some industrial facilities in the western portion, while high tech dominates in the urban corridor between Baltimore and Washington, DC. Traditional industrial activity in places like Pittsburgh, Pennsylvania, and Illinois has been declining over the last 30 years, while Seattle metro is one of the fastest growing areas in the country. The economies of Maryland and Virginia are also strong in large part due to proximity to the nation's capital, Washington, DC. Relative economic strength is reflected in household income levels. The Seattle metro area, Maryland, and Virginia have household incomes that are higher than the national average of about $50,000 per year. Maryland ranks 1st nationally. Illinois, Pennsylvania, and the Pittsburgh metro area have household incomes at or slightly less than the national average.

Table 2: Selected General Statistics about US Jurisdictions[55]

State or Local Agency	Population (million) (2015 unless otherwise stated)	Size (km^2)	Median Household Income (2015$)	NO_X Emissions Point Source Fuel Combustion (tons, 2011)[56]	$PM_{2.5}$ Emissions Point Source Fuel Combustion (tons, 2011)[57]
Allegheny County, Pennsylvania (Pittsburgh metro area)	1.2 (2014)	1,930	51,366	10,320	2,595
Bay Area, California (San Francisco metro area)	7.6 (2014) (nine counties)	18,088	73,562 (2011)	18,850	7,850
Illinois	12.9	149,998	54,124	209,050	22,245
Maryland	6.0	32,133	73,538	37,300	8,775
Puget Sound, Washington (Seattle-Tacoma metro area)	3.8	15,209	63,088 (2010)	5,870	9,510
Virginia	8.4	110,786	61,044	63,730	16,975

[54] Personal communication between Chris James and Stephanie Cooper of the NACAA, February 2016.
[55] Data available at: www.wikipedia.org and US Census Bureau quickfacts.census.gov.
[56] US EPA. (2011). *National Emission Inventory*. (Most recent version). Retrieved from http://www3.epa.gov/ttnchie1/net/2011inventory.html (user driven, report for each state, sector and pollutant).
[57] US EPA (2011).

General characteristics of a jurisdiction, i.e., population, size, income level, major source categories, number of sources, etc., may affect the budget and staff resources required to run an effective permitting program. Table 2 includes general information about each sample jurisdiction by way of background context to inform subsequent Tables 3 and 4.

Permit Fees

As China considers a permitting program, it is important to also consider the costs associated with implementation and enforcement of such a program. Permitting fees are one way that the US system ensures that there is adequate funding to cover the reasonable costs of the permit program. China could consider using this type of system and identifying the types of activities that such fees might cover.

State and local agencies collect different types of fees for different purposes. Fees for construction and operating permits (non-Title V or minor source fees) are intended to cover the agency's cost to review and process each application. Many agencies require additional fees to be paid for complex permit applications, for example those requiring review of modeling or determination as to whether additional emissions will cause or contribute to a violation of ambient air quality standards. Many agencies also charge annual fees for each enterprise to help cover the costs to inspect the enterprise each year.

As Table 3 shows, permit fees vary significantly by jurisdiction and by type of permit. In addition to a fee per ton emission, most agencies charge an annual administrative fee for both major and minor pollution sources. State and local agencies prepare annual budgets and strategic plans that detail the workload and priority pollution control areas, identify funding sources, and describe the resources needed to accomplish the expected tasks. A good example of an annual budget and strategic plan is that prepared by the Puget Sound Clean Air Agency.[58]

[58] Puget Sound Clean Air Agency.

Table 3: Selected Examples of Permit Types and Fee Structures

State or Local Agency	Construction		Operating		Title V	Other
	Major Source	Minor Source	Major Source	Minor Source	($/ton) (2015, adjusted annually)	
Allegheny County, Pennsylvania (Pittsburgh metro area)[59]	$22,700 (incl. attainment and modeling review)	$1,000	$750/ year (in addition to $86.34 per ton)	$375/year	$86.34	Ownership transfer fee: 25% that of operating permit
Bay Area, California (San Francisco metro area)[60,61] Fees set by type of source, e.g., Fuel combustion: $61.75 per million Btu per hour (minimum fee: $330, maximum $115,199). Organic liquid storage (petroleum refinery, chemical plant): 0.181 cents per gallon. Minimum fee: $200. Maximum fee: $27,258	All sources must pay: filing fee $452, an initial fee, risk screening fee, permit to operate fee, and toxic surcharge fee.	All sources must pay: filing fee $452, an initial fee, risk screening fee, permit to operate fee, and toxic surcharge fee.	Fees set by type of source (applies to major and minor sources), e.g., fuel combustion: $30.86 per million Btu per hour. Minimum fee: $234. Maximum $57,299. Organic liquid storage (petroleum refinery, chemical plant): 0.091 cents per gallon. Minimum fee: $144. Maximum $13,628.	Renewal fee $89-876 (for enterprises from 1 to more than 20 permitted sources, including gasoline stations)	$110 (criteria pollutants) $0.10 (GHG)	Toxic pollutant fee: 10% of the source fee. Annual assessment to nine counties (based on population): $23 million total in 2014. Certificate of exemption: $452 (for facilities seeking to be exempt from permitting). Hearing board fees: $195-579 (small businesses), $961-3,873 (large businesses); plus $1,939-3,873 per hearing day.
Illinois[62, 63]	$4,000 (1st unit) $2,000 (modification to existing unit) $10,000 maximum	$500 to $1,000 Complex source: up to $10,000	Covered under Title V program	$235/year (enterprise with <25 tons), $21.50 per ton (enterprise emissions 25-100 tons)	$21.50 (enterprise emissions of 100-13,888 tons) $294,000 (cap for enterprises with emissions	$10,000 public hearing fee $4,000 fee to transition from major to minor source

59 Allegheny County Health Department permit fees: http://www.achd.net/air/pubs/pdf/AQ_FeeSchedule.pdf.

60 Personal communication, Pam Leong, Bay Area Air Quality Management District, February 2016.

61 Bay Area Air Quality Management District, Regulation 3, Fees. Retrieved from http://www.baaqmd.gov/~/media/files/planning-and-research/rules-and-regs/reg-03/reg300_060315-pdf.pdf?la=en.

62 Illinois EPA Construction fees. Retrieved from http://www.epa.illinois.gov/topics/forms/fees/construction/index

63 Illinois EPA Minor Source Operating Permit fees. Retrieved from http://www.epa.illinois.gov/topics/forms/fees/non-Title-v-operating/index

	Greenfield source: $5,000 Complex source: $12,000 to $25,000				more than 13,888 tons)[64]	
Puget Sound, Washington (Seattle-Tacoma metro area)[65]	$1,150 (base fee)	$1,150 (base fee)	Information not available for individual sources	$2.7 million per year collected from 3,500 sources	$1.3-1.5 million per year collected from 31 sources	Annual per capita assessment. $0.81 per capita in 2015[66]
Virginia[67]	$31,558 (nonattainment review) $15,779 (all others)	$1,577 $788 (permit amendment)	$21,039 (initial Title V permit) $10,519 (Title V permit renewal) $7,363 (state operating permit) $10,519 per year (complex) $3,681 per year (not complex)	$1,051 per year	$60.91 (fee capped at 4,000 tons per year)	~$1 million per year received from permit construction and modification) ~$10 million per year received from Title V sources

Title V Permit Fees

Title V fees for major source operating permits originated from the 1990 Amendments to the Clean Air Act. EPA established a presumptively minimum unit fee of $25 per ton of pollutant emitted by the enterprise (not including CO_2). The unit fee was also required to be adjusted each year in accordance with the Consumer Price Index. The purpose of these requirements was to ensure that state and local agencies collect fees to cover all reasonable (direct and indirect) costs associated with the permit program. Such costs may include, for example, adequate personnel and funding to administer the program such as issuance and enforcement of permits including facility audits and inspections. The concept was that by requiring revenue collection, implementation could be better assured.

There was and continues to be debate over how best to structure permit fees. Some have suggested that how many pollutants a source emits does not necessarily correlate to the burden of developing and enforcing a permit as borne by the state or local permitting agency. For example, while coal-fired power plants are large, emitting thousands of tons (or more) of pollutants each year, these sources have fewer emission points, and the record keeping and reporting requirements are well established (e.g., fuel sampling, continuous emissions monitors to record pollutant concentrations, etc.). Petroleum refineries, pulp and paper plants, and automotive manufacturing plants, in contrast, may have several hundred

64 Illinois EPA Title V fees. Retrieved from http://www.epa.illinois.gov/topics/forms/fees/clean-air-Title-v/index
65 Personal communication, Karen Houser, Puget Sound Clean Air Agency, January 2016.
66 Memorandum to Puget Sound Board of Directors. (2015). Resolution 1323—Adopting the FY16 Budget. Retrieved from http://www.pscleanair.org/library/Documents/PSCAA-FY16Budget.pdf Per capita assessments reflected on pp. 23-25.
67 2016 Air Permit Program Fees. Retrieved from http://www.deq.virginia.gov/Portals/0/DEQ/Air/Permitting/air_fees.pdf; Fees Under the Virginia Air Pollution Control Law. Retrieved from http://www.deq.virginia.gov/Programs/Air/FeesUndertheVAAirPollutionControlLaw.aspx

discrete emission points and diverse processes which influence the type of emissions and associated recording keeping and reporting requirements. Thus, some permitting authorities might take the position that more labor is often required to review and issue an operating permit for an automotive manufacturing plant emitting 500 tons of pollutants each year, for example, than for a power plant that may emit 10,000 or more tons of pollutants each year. For this reason, many agencies initially formulated a two-part fee, based on pollutants emitted and labor requirements.

A second factor that may influence emission fees is the number of Title V sources in any jurisdiction. Agencies with fewer Title V sources initially had higher pollution fees. There are administrative costs to operating a Title V program regardless of the number of sources, so costs are lower on a per source basis in states with many Title V sources.

Take for example, Illinois, which has low Title V fees compared to those in other states shown in Table 3. Illinois is a large, industrialized state which also has many coal-fired power plants compared to other states. Jurisdictions with fewer sources and those where power plants have less influence on the total emissions inventory have tended to have higher Title V operating permit fees.

The amount and structure of Title V fees has changed over the past two decades. Today, it is common for states to assess some minimum or base fee to all sources, then the emissions fee per ton of pollutant is added to that base fee. Over time, as enterprises reduced their emissions, many took advantage of state programs that allowed enterprises to be exempt from the Title V program if the enterprise accepted a permit modification that restricts annual emissions to less than the Title V threshold. A combination of these two factors reduced both the annual emissions and the number of affected Title V sources. While this trend improved air quality, there are minimum costs associated with administering each Title V permit and the program as a whole, regardless of the number of affected enterprises or their total emissions. As a result, many states today have both increased their per ton emission fees *and* established a base fee that all Title V sources must pay. The base fee is also applied to minor sources, including those that were former Title V sources who reduced or otherwise restricted their total emissions to below the applicable thresholds required to obtain a Title V permit.

Construction Permit Fees

State and local agencies in the United States also typically require enterprises to pay a fee when they apply to construct a new facility or add a new emissions point. Fees must be paid by the enterprise before the agency will begin processing the permit. The fee for modifying an existing enterprise or emissions point is the same as a new application fee if the modification will result in an increase in air pollutants. The construction permit fee varies based on the complexity of the activity(ies) proposed by the enterprise. A new or modified major source has a higher fee than that for a new or modified minor source. If a permit agency has to review ambient air quality or dispersion modeling results, or conduct such modeling themselves, additional fees are required. All new or modified permits are subject to public comment and review. Some agencies (e.g., Illinois in Table 3) require an additional fee if a public hearing is held. Construction permit fees of up to $40,000 (per Maryland in Table 3) reflect the agency resources required to process a permit and respond to public comment. The number of new or modified construction permits processed each year is linked to local, regional, or national economic activity. Fewer construction permits are typically issued during economic recessions compared to periods of strong economic growth.

Non-Title V Operating Permit Fees

State and local agencies also assess base and annual fees for sources not subject to the Title V program, called minor source fees. In terms of numbers, there are many more minor than major sources. For example, Table 4 shows that Allegheny County, Illinois, and Puget Sound have a 10:1 ratio between minor and major sources. While minor sources may have fewer applicable requirements than major sources, state resources are required to process such permits and to ensure compliance once the permit is issued.

Other Types of Permit Fees

There are other permits required and issued by US air quality agencies. Since the authority to develop and administer air quality programs is primarily that of the states, with EPA oversight, agencies have established other types of permits and fees to address local or state needs. These include:

- *General permit or permit by rule*: A small one-time application fee of $50-300 is often required. The enterprise complies with the terms and conditions of the general permit or rule, and is registered in the state emissions inventory system. A small annual fee may also be required.
- *Registration fees*: These fees are mostly legacies of permits issued prior to the establishment of the Title V program, or for minor sources that existed prior to the establishment of a state permit program. Small annual fees are collected by some agencies.
- *Risk-based fees*: The Bay Area Air Quality Management District charges fees based on the quantity and type of toxic air pollutants emitted.

The Bay Area and Puget Sound permit fees represent a hybrid approach. Fees are charged for specific processes and based on the quantity of pollutants emitted. However, both agencies also collect revenue from local counties to help diversify program funding. The Bay Area also charges fees based on the capacity or throughput of processes and upon the risk burden imposed to the public from the emission of hazardous air pollutants. This approach is analogous to that taken by the UK Environment Agency (discussed below), though the UK and Bay Area use different protocols and methodologies to calculate permit fees.

Table 4: Program Description–Selected Examples[68]

State or Local Agency	Title V Permits	Minor or Other Permits or Registrations	Number of Staff and Managers	Budget ($ per year) $ million	Comments
Allegheny County, Pennsylvania	35	375	7 staff 1 manager (8 total)	0.69	
Bay Area, California (San Francisco metro area)[69]	100	11,000 facilities 24,000 emission sources (30% of these <10 tons per year)	65 total staff and managers	35	1200-3000 permit applications processed annually (depending on economy)
Illinois	550	980 state permits to operate (non Title V) ~6,000 minor sources	Title V: 19 staff, 1 manager (20 total) Major Source Construction: 6 staff, 1 manager (7 total) Minor Source operating permits: 8 staff, 1 manager (9 total) Open burning: 1 staff All units: 34 staff, 3 managers (37 total)	17 (total air agency budget)	
Maryland[70]	121	344 (state permits to operate)	4 managers, 15 permit engineers, 5 administrative/support staff	2.17	~700 state permits to operate issued annually
Puget Sound, Washington (Seattle-Tacoma metro area)[71]	31	3,500	7.7 permit staff 1 manager (8.7 total)	1.1	
Virginia[72]	250	1575	42 staff, 6 managers (one manager for each of six regional offices), 6 support staff (54 total)	3.1	~500 permits issued annually. Of these 250 are for minor sources

Staffing and Technical Expertise

While fee structures vary, approaches to staffing and management are more consistent across state programs. Each agency typically has an "air division" and within that division there is usually a permit or engineering division responsible for processing permits. That division is comprised of several permit engineers or other specialists and one (or more) managers. Larger states may organize themselves along sector-based lines, such as having one permit section for combustion sources, another for chemical plants, a third for iron and steel, etc. Staff with engineering or science expertise are responsible for reviewing the permit and developing its terms and conditions. Chemical and mechanical engineers are the most represented among permit staff. Some agency staff also have expertise in industrial and

68 State and local agency information in this table obtained from —Maryland: personal communication, Karen Irons, Maryland Department of the Environment, January 2016. Virginia: personal communication, Tamara Thompson, Virginia Department of Environmental Quality, January 2016. Allegheny County, PA: personal communication, Jamie Graham, Allegheny County Health Department, January 2016. Illinois: personal communication, Robert Smet, Illinois EPA, January 2016. Puget Sound: personal communication, Karen Houser, Puget Sound Clean Air Agency, January 2016.

69 Personal communication, Pam Leong, Bay Area Air Quality Management District, February 2016. [Supra footnote 60.]

70 Personal communication, Karen Irons, Maryland Department of the Environment, February 2016.

71 Personal communications, Karen Houser, Puget Sound Clean Air Agency, January 2016.

72 Personal communications, Tamara Thompson, Virginia Department of Environmental Quality, January 2016.

atmospheric chemistry. The permitting section or division generally has the highest concentration of staff with technical degrees, and also the highest concentration of staff with advanced degrees. However, staff with bachelor level engineering or science degrees are adequate for most agencies. Typically, the permit division is headed by a person with an advanced engineering or science degree. A few may have a doctorate degree in science or engineering. Many section or division leaders were also permit engineers themselves, and were promoted to be the section or division leader.

Administrative or support staff process permit fees, track permit timelines (states have certain periods of time to determine an application complete, process a permit, and for public review and comment), and are initial points of contact for permit applicants. These personnel have two- or four-year non-engineering or science degrees. In smaller agencies, such as Allegheny County, one support person handles many functions, not just permits. In larger agencies, such as Maryland and Illinois, specific support staff are assigned to the permitting sections or division. Computer support is usually provided by contractors or by staff responsible for the entire state or local agency.

While state and local agencies issued construction and operating permits for decades, many agencies hired staff following the 1990 Amendments to the CAA for implementation of Title V. For example, the EPA's and the California Air Resources Board's (CARB) air quality training curriculums were revised and expanded to respond to the new demand. In the mid-1990s these courses were held at specific times and locations, requiring in-person attendance. Each course was taught by a certified instructor or EPA/CARB staff and took two to four days of time to complete. Neither the EPA nor CARB charged fees for government staff. However, due to significant demand and limited space for in-person EPA or CARB training, private companies also held courses, and for these a fee of $400-1,000 (typical range) was charged. As the Internet became widely used, the EPA and CARB recorded their training courses to make them available on demand so agency staff could learn about various topics whenever they wanted, and without having to require travel to a particular location. The EPA and CARB both maintain extensive video course libraries today.[73, 74]

The EPA's Air Pollution Training Institute also administered a grant program that paid for university tuition at graduate schools for qualifying air pollution agency staff.[75] Typically only a dozen or so grants were issued each year, but it allowed junior agency staff to deepen their learning, to develop professionally, and be a greater resource to their agency. Qualifying applicants were required to work two years at a government agency for each year of tuition they received.

[73] Link to all EPA Air Pollution Training Institute courses: http://www3.epa.gov/apti/video/index.html.

[74] Link to the CARB air pollution training portal: http://www.arb.ca.gov/webtraining/.

[75] Agency staff applied to the EPA in a competitive process. If approved, funds were provided by the EPA's Office of Air Quality Planning and Standards. Qualifying students had to submit transcripts with their grades each semester.

United Kingdom Resources and Technical Capacities

Table 5: Selected General Statistics About EU Jurisdictions[76]

Country	Population (million) (year)	Size (km^2)	GDP
United Kingdom	65.1 (2016)	242,495	$43,771 (2015)
Germany	81.4 (2015)	357,168	$41,267 (2015)
Sweden	9.8 (2015)	450,295	$48,966 (2015)

In the United Kingdom (UK), permits are issued by permitting authorities in the four component jurisdictions of the UK, i.e., England, Wales, Scotland, and Northern Ireland. Each jurisdiction has its own implementing legislation. The UK has a total of about 20,000 permits, of which 1,000 are related to the Industrial Emissions Directive. England issues about 75 percent of all UK permits through three centralized permit offices with a total staff of about 200 people. Most of the staff hold university degrees in engineering or chemistry. Permit fees in the UK are collected to cover the costs of permitting staff, and are adjusted each year to reflect changes in the rate of inflation. Permitting staff are encouraged to rotate to other units, to become familiar with other types of industries, and also to rotate to one of 16 area inspector centers, which are responsible for enterprise audits and compliance assurance. Longer-term, career staff can aspire to take on management responsibilities.

The UK's permitting system (and that of Europe in general) is quite different from that of the United States. Multi-pollutant and multi-media permits are issued, per the EU Industrial Emissions Directive (discussed earlier). The UK's multi-pollutant focus was informed by a 1976 report of the Royal Commission on Environmental Pollution,[77] and has operated an integrated pollution control system since 1990. England's expertise helped to inform work by the EU Commission to launch the first Integrated Pollution Prevention and Control Directive in 1996.

The multi-pollutant and multi-media scope of the UK permitting program results in a different staffing and fee structure from that of the United States. While the educational backgrounds of permit staff in the UK also largely pertain to engineering and scientific disciplines, the broader program scope means that each staff person in the UK has fewer enterprises for which he or she is responsible, but that these responsibilities cover all media and pollutants. In the United States, air quality staff review and approve air permits, while water quality staff do the same for water, etc. Some US states recognize the benefits of coordinated permit review, and there are efforts made to synchronize permit processing for major construction or modifications that touch on requirements across several media. However, these are case-by-case, and not routine practice as it has been in the UK (and European Union) for several decades. The multi-pollutant and multi-media aspects of the UK permit system mean that a permit engineer is familiar with the entire operation of an enterprise. This depth is useful, especially in processes where an enterprise can control the rates of air quality or water discharges. From management and professional career perspectives, to maintain freshness and offer avenues for professional advancement the UK system encourages staff to periodically rotate, to be responsible for different industrial sectors, and to advance to a supervisory or management level if the staff person is qualified and interested.

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[76] Source: www.wikipedia.org (for all countries).

[77] Royal Commission on Environmental Pollution. (1976). [Supra footnote 50.]

As part of the EU ETS, the UK assesses CO_2 emissions fees based on the total annual emissions at each enterprise. Table 6 addresses fees in the UK for sources subject to the Emissions Trading System.

Table 6: EU ETS Permit Fees in the UK

Enterprise Size (based on annual emissions)	Application Fee (in local currency)	Annual Fee (in local currency)	Other Fees
<50 kilotonnes (kt) per year[78]	£1,340	£2,550	£430 allowance[79] transfer or variation £670 allowance surrender £125 per hour for failure to submit annual report (fee for agency to calculate emissions)
50-500 kt per year	£2,500	£3,320	£430 allowance transfer or variation £670 allowance surrender £125 per hour for failure to submit annual report (fee for agency to calculate emissions)
>500 kt per year	£5,970	£4,080	£430 allowance transfer or variation £670 allowance surrender £125 per hour for failure to submit annual report (fee for agency to calculate emissions)
Non-emitter		£980	£1,120 application to increase emissions for non-emitter

For other pollutants, the UK assesses permit fees using a risk-based system, called OPRA (Operational Risk Assessment). The IED is the chief regulatory mechanism applicable to thermal power plants and other industrial sources. To implement IED, the UK uses OPRA to rank these sources in terms of their complexity, geographic location, and actual emissions. The enterprise calculates its OPRA score (in bands from A to E based on the complexity of the enterprise) in accordance with published guidance.[80] Then, points for each attribute are calculated based on the particular OPRA band, using Table 7 below.[81]

Table 7:OPRA Band Scores (Used in the UK to Calculate Permit Fees)

Attribute		Band Score				
		A	B	C	D	E
Complexity	Note - each activity is scored	2	15	45	82	110
Emissions	Air	3	10	20	35	50
	Water	3	10	20	35	50
	Land	3	10	20	35	50
	Waste input	3	10	20	35	50
	Sewer	1	2	3	5	10
	Off-site waste	1	2	3	5	10
Location		3	10	20	40	60
Operator Performance		10	25	40	60	75

The last step is to determine the application and annual fees. This value is the product of the number of points calculated by Table 7 and the specific activities shown in Table 8.[82]

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78 EU ETS Installation Charges. Retrieved from https://www.gov.uk/guidance/eu-ets-charges#eu-ets-installation-charges.
79 Note that in the EU ETS, the term "permit" is often used interchangeably with the term "allowance" to signify a tradable certificate representing a ton of emissions. For clarity, the term "allowance" is used here. This is consistent with the practice in the United States, where allowances are issued by the EPA and states for acid rain and GHG market-based programs.
80 Environment Agency. (2014). *OPRA for EPR version 3.9, Annex A—OPRA for Installations*. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301773/LIT_6817.pdf
81 Environment Agency. (2014). Table 24, page 45.
82 Environment Agency. (2014). Table 25, p. 45.

Table 8: UK Permit Fee Multipliers (for each OPRA point)

Charge	Installations
	Multiplier (£)
Permit Application charge	206
Subsistence charge	101
Normal Variation charge	58
Substantial Variation charge	113
Full Surrender charge	127
Partial Surrender charge	99

For example, a thermal power plant sized greater than 300 MW is classified as band D using the OPRA manual (see Table 1, page 13 of the manual). Band D equals 82 points for complexity, 35 points each for air, water, land and waste discharges, 5 points for sewer, 5 for off-site, 40 for location and 60 for operator performance, for a total of 332 points. This enterprise would be assessed a one-off fee of £68,392 for the initial permit application, and an ongoing annual fee (the "subsistence charge") of £33.532. The OPRA manual provides OPRA band classifications for the different types of industries covered by the IED, as well as other permitting regimes. Each activity receives its own OPRA classification and is assessed fees accordingly. There are procedures to group like activities together (e.g., an enterprise with several small surface coating processes), but as a general principle multiple activities located at the same location will pay multiple fees.

Summary and Recommendations Related to Permit Program Management, Staffing and Fees:

As described earlier, there are different methods for ensuring that a permit program is adequately funded both initially and as an ongoing matter. Despite the range of approaches described above, several key lessons emerge for consideration by China as it considers options for fee structures, staffing, and program management:

- Revenue collected from permits should be adequate to pay for staff, management, administrative support, and overhead (building rent, travel, equipment, etc.). Such revenues could also include funding to support the ambient air quality monitoring network and to conduct facility inspections to assess compliance.
- The number and complexity of permits will drive demands on resources and staff. A large source with few emissions points may require less agency resources than a complex source regardless of size. For example, a power plant has relatively few emissions points, but thousands of tons of pollutants (or more) can be emitted through each point. Conversely, petroleum refineries can have hundreds of emissions points and many fugitive discharges, many of which are relatively small. So, a permit system where fees are derived solely from the quantity of emissions may not align with the overall work stream from all enterprises. Therefore, a well-designed fee structure will take multiple factors into account.
    - One option would be to include a fee component that is a standard application fee for all enterprises, regardless of size. There are certain administrative procedures that must be done to enter an enterprise into a system, and the quantity of emissions is not a big factor in determining these associated administrative costs. For example, an agency could assess a base fee of a certain amount, then require additional fees proportional to the complexity of the permit review.

  - Another option would be to follow a consultancy model where the enterprise pays an hourly rate for the permit review.
  - Yet another option is to institute a system along the lines of that used in England or the Bay Area, which takes into account source complexity, geographic location, the quantity and type of pollutants emitted, the capacity or throughput of a process, and the health risks from any hazardous pollutants that are emitted.
- Appropriately aligned permitting fees can create incentives to reduce emissions and drive technological improvements, while allowing for increased growth.
- If possible, the type of fees to be assessed can be established in a related regulation, with reference to a manual where the actual fees and the protocols used to determine them are detailed. This ensures that an implementing agency has access to the resources needed to execute its responsibilities. The manual can be updated as needed and usually requires less burdensome procedures than those required to revise a regulation.[83]
- Factors that influence the number and type of permits issued will change over time, i.e., the rates of economic and population growth, changes in the emissions inventory, and new statutory or regulatory requirements. Cross-training of staff in several disciplines provides the agency with flexibility to accommodate large but temporary increases in permit activities.
- Permitting programs require engineers and scientists whose duties are to review and recommend approval or denial of a permit. Management strategies can be aimed at retaining and promoting these staff through training, cross-sector/cross-department assignments, and opportunities to advance to management if they so aspire to do so.
- The role of the provincial agency is to review the applications and audit the tests to make sure that all protocols are followed. Enterprises pay for the costs to develop the permit application and any audits or tests. Consultants can directly help the enterprises to prepare permit applications, and to test emissions and discharge points to determine compliance with permit conditions. While the enterprise pays those consultant fees, government can play a role in encouraging the creation and expansion of a third party industry of consultants, auditors, and equipment suppliers.

The programs China puts in place now may need to be dynamic, flexible, and subject to revision in order to meet the growing needs of the economy and environment over time. Lessons from the United States and European experience can help inform authorities as they determine the fee structures and other program features appropriate to meet China's needs.

Part IV: Recommendations

As China establishes a strong national permitting program to control emissions from new and existing sources of pollution, prioritizing certain regulatory programs, sectors, regions, and pollutants on which to focus initially is a pragmatic approach. In US and EU experience, the permit typically encompasses all applicable requirements to which a facility is subject, and programs include mechanisms for modifying a permit over time to incorporate any new regulations affecting a facility. The permit therefore has flexibility to accommodate changes in policy, environmental circumstances, or institutional or

[83] This process is referred to as "incorporate by reference" (IBR), and is routinely used for test procedures and protocols. A few states have also done so for permit fees. The calculation is shown in the regulation, but the input variables are subject to change. Public review and comment is requested for IBR processes, but these do not require legislative approval.

procedural needs as they emerge. In China's case, while the scope of permitting activities may be limited initially, as capacity is built at implementing agencies the program can be expanded to become a fully-fledged pollution source permitting program covering all major sources. To take a phase approach, however, it will be important to have a clear understanding of the end-goal and a roadmap for achieving it, so that the information technologies, tools, and practices put in place today by environmental agencies across the country will serve to enable this work in the future.

To that end, this section presents lessons and recommendations from international experience that may help steer the development of China's permitting system. This paper began by enumerating nine general principles that are important for any permitting program. In this final section, we relate recommendations to each of these general principles.

1. **Build continuity between emissions at their source and air quality goals**

A permitting program provides the critical linkage between air quality goals (top down) and facility-level emissions (bottom-up). In US and EU experience, the permit is a chief regulatory instrument through which an environmental agency can ensure that emissions limits are adequate to attain or maintain good air quality. Important provisions for building this continuity into a permitting program include:

- Enterprises should be required to conduct dispersion modeling to determine the impact of proposed activities on air quality relative to the ambient air quality standards. Air quality modeling analysis can be used to assess impacts within its jurisdiction and in jurisdictions that may be affected downwind.
- All proposed new or modified activities should be subject to technology review. Enterprises should be required to install or use the best technologies and processes to achieve emissions levels consistent with air quality goals. Baseline control levels would be equivalent to the LAER.
- The use of offsets in preconstruction permitting (akin to China's environmental impact assessment) can be designed with transparent rules for accreditation that more systematically align with air quality goals.
- Emissions and operational data collected from the facility to verify compliance can be used to support and improve emissions inventories and air quality models, and to cross-check ambient air quality data.

2. **Include mechanisms to balance economic growth and environmental impacts.**

The permit program can be designed with degrees of stringency to create room for continued economic growth in areas where environmental goals are being achieved. For instance, certain emissions limits and other requisite provisions for permit applicants may apply depending on an area's air quality status relative to health-based standards. In the United States, in areas that meet air quality standards, BACT is required, as well as air quality modeling to demonstrate that projected emissions will not exceed a given incremental increase in pollutant concentrations levels. In areas that exceed the air quality standards, a more stringent LAER emissions limit is required, and facilities must offset their emissions to ensure that the new emissions source will not result in a net increase in pollutant concentrations. The Chinese system should incorporate and strengthen these kinds of mechanisms to promote growth and achieve environmental objectives while bringing all affected pollution sources into a common compliance system, thereby eliminating the economic advantage of non-compliance and creating a level playing field.

3. **Assure compliance with applicable requirements**.

A permit serves to catalogue all applicable requirements affecting a facility, thereby strengthening the legal enforceability of those requirements and offering transparency to the regulated sources as well as the surrounding community. This consolidation into a single document of all applicable requirements is one of the most valuable features of a permit. This gives the facility owner/operator and the oversight agency a common understanding of the full range of regulatory requirements and provides the basis for carrying out compliance determinations and enforcement activities for the air agency staff. The following aspects of a permit program can help assure compliance:

- The permit should include all applicable terms and conditions from standards, regulations, and directives affecting a facility.
- The terms of the permit should clearly explain the methods of compliance determination.
- The permit should identify the specific records to be kept and data to be reported that will enable the air agency to assess compliance with all applicable requirements. Data should be linked to operating and process parameters that influence emissions, or directly record what is being emitted (i.e., through CEMS). Much of the data collected by enterprises for business purposes, i.e., production, costs of sales, materials used for manufacturing, operation of emissions control equipment, etc., are relevant to compliance with environmental requirements. Permit writers can ascertain what variables and parameters are being maintained by an enterprise for production purposes, and include relevant parameters in the permit. The permit can specify that the enterprise maintain records so that data are regularly reported to the permitting authority and made available for viewing by an inspector.
- Agency staff should conduct periodic, routine (and preferably unannounced) inspections of the enterprise to determine compliance, and audit records and reports. Inspections conducted after construction is completed help to verify that the equipment installed is consistent with what has been permitted. Inspections can also serve to inform enterprises of new or revised requirements, and to answer any questions they have.

4. **Confer adequate management authority on the environmental agency at the national level**.

A strong oversight authority at the central level, with clearly defined responsibilities across tiers of government, can help to ensure consistent performance across different jurisdictions. This is particularly important in addressing sources in a large and economically diverse country like China. For effective and consistent implementation, the central environmental agency should possess the clear and well-defined authority to intervene as necessary.

For example, the Ministry of Environmental Protection could be given the responsibility to ensure that:

- Permits include required contents,
- The required procedures are followed,
- The emissions limits are sufficient to result in attainment of air quality standards, and
- Emissions from permitted sources will not significantly degrade air quality in downwind jurisdictions.

To uphold these responsibilities, the Ministry of Environmental Protection should be afforded a review period before the permit is issued and the power to veto a permit that does not meet stated regulatory requirements.

Having strong central management will be especially crucial for resolving air pollution that is transported across jurisdictions. The central agency should be charged with overseeing a mechanism by which downwind jurisdictions may contest a permit that will impair its ability to meet air quality targets and be provisioned with explicit authority to act to preclude such impairment.

5. **Create incentives for compliance.**

The permit, both its process and content, should be designed to encourage compliance. The process, for example, can stipulate provisions for directly engaging the owner/operator in the permit drafting and in the preparation of related information, helping to ensure that the regulated entity fully understands the requirements and is engaged and committed to the decision-making process. Input from the enterprise can also be helpful to designing permit terms and conditions that work. Enterprises know their business and processes, and often have good suggestions for techniques to monitor production and emissions that can satisfy air agency needs to assess compliance. Additionally, by assigning personal responsibility for certifying and reporting data to a company executive, the permit can create accountability within the company and improve data quality.

The content of the permit can also be designed to create incentives for compliance by taking advantage of new monitoring and information technologies, public disclosure and transparency, and innovative approaches to targeting enforcement. Examples include requirements for:

- Electronic reporting using systems that guide the user through integrated compliance assistance and data quality checks;
- Automated penalties and incentives;
- Electronic reporting to the public of pollution discharges, communicated relative to terms of compliance;
- Self-monitoring of environmental performance using operational parameters or other compliance data;
- Advanced monitoring, i.e., mobile monitoring units, infrared cameras, fence line monitors, drones, etc., to spot pollution and compliance issues.[84]

These kinds of measures are aimed at involving the regulated entities in ways that help the facility managers, as well as regulators, identify and respond to pollution problems rapidly.

6. **Provide transparency**.

Transparency in all stages of the decision-making process provides the basis of accountability. An effective permitting program must provide:

- Clear rules and procedures;
- Clear obligations and standards;
- Clear consequences for violating the rules;
- Reasons for permit decisions;
- Public access to draft and final permits; and
- Public access to compliance data.

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[84] US EPA. (2014). *Next Generation Compliance: Strategic Plan 2014-2017.* Retrieved from https://www.epa.gov/sites/production/files/2014-09/documents/next-gen-compliance-strategic-plan-2014-2017.pdf

This information must be made readily and reliably accessible to both the public and the regulated entities to foster trust in the permitting outcomes. Requiring transparency can provide incentive for compliance, as well as improve coordination between jurisdictions, evaluate consistency across jurisdictions, and enhance oversight by the central authorities.

7. **Engage the public in the decision-making process.**

Public involvement in the permitting process also helps foster public confidence and promote accountability. The four steps below help to engage the public, and provide certainty for the regulated entity. The relevant permitting authority:

(1) Publishes a notice to the public that includes:
  - A draft version of the permit;
  - Deadlines for submitting comments and for requesting a public hearing related to the draft permit.

(2) Receives comments from the public, industry, and other states.

(3) Evaluates the comments it has received and publishes a response to comments, which explains its decisions to accept or reject comments and make or not make changes to the permit accordingly. In cases where the permitting authority significantly revises the draft permit, it may publish a notice and seek comments on the revised permit.

(4) Issues a revised permit.

In this process, supporting documentation and emissions monitoring information are made publically available. All related information received by the permitting authority, including supporting documentation, emissions data, comments received, and the response to comments, are entered into the public record and provide an administrative record for evaluating the final decision in the event of judicial review. It is through transparency and public engagement that the regulatory authorities foster accountability and trust.

Chinese air quality agencies can solicit feedback from multiple audiences through such means as public education and outreach, translating technical science for lay audiences, among other approaches. Because stakeholders often bring a local vantage point in identifying problems and proposing solutions, public involvement can lead to more robust and informed decisions, simplifying the work of the permitting authority and offering a counterbalance to what may be powerful economic interests behind a project proposal. US and EU experiences have shown that public engagement often leads to better environmental outcomes.

In addition to engaging the public in the agency's permitting process, it is equally important that the public have an opportunity to appeal the agency's permit decisions to an independent tribunal in an open and transparent process. Giving the public an opportunity to challenge permit decisions instills greater public confidence in the agency's permitting process. It does so by ensuring that permit decisions are based on an objective application of the relevant law to the facts at hand and that the agency has adequately justified the basis for its decision to issue or deny a permit, including its decisions to accept or reject public comments received.

8. **Streamline procedures to balance efficiency and effectiveness.**

Air agency resources should be managed efficiently. For the thousands of small sources like auto body shops, restaurants, dry cleaners, screen printing, etc., implementing agencies should develop general permits that establish a default level of emissions control for those source categories. Enterprises would register with the Environmental Protection Bureaus/Department, and by doing so would receive approval to construct and operate the process. General permits can be considered as "permits by rule"; this process uses agency resources efficiently, allowing greater focus on major sources where permits must be developed on a case-by-case basis.

China is facing the challenge of implementing multiple energy and environmental initiatives simultaneously. Monitoring, reporting, and verification procedures for CO_2 emissions trading are being developed simultaneously–yet separately–from related monitoring, reporting, and verification procedures for other air emissions. With both programs requiring essentially the same data from the same facilities, GHG and air pollutant emissions is an example where streamlining data collection and integrating monitoring and reporting requirements would have obvious benefits. There are many other instances of concurrent policy initiatives that would benefit from greater coordination as well.

China's ambitious clean energy targets–recognized in the recently revised Air Pollution Prevention and Control Law, which requires deployment of green electricity dispatch, renewable energy, and energy efficiency policies to achieve air quality goals—could readily be reinforced through the terms and conditions of emissions source permits. For example, permits could be used to require enterprises to conduct periodic audits of their processes to improve energy consumption. Or, as part of the process to obtain approval, enterprises could be required to use renewable energy and energy efficiency to offset the environmental impact of increased energy consumption. A dialogue between China's environmental and energy planners could reveal areas where a permit system would help to implement the mutual objectives across the air quality, climate change, and energy sectors.

9. **Ensure the program has adequate and secure sources of funding.**

Development and implementation of a permitting program is resource intensive. To achieve process consistency, and to ensure that the permitting program is a well-integrated component of the air quality management system, trained staff are essential. Staff liaise with the affected enterprises, engage the public, and review often complex scientific and engineering information to prepare decisions regarding an application to construct or modify an enterprise. In the long term, permitting programs in China will need to expand and change as additional air quality regulations are adopted and affected by varying economic cycles. Professional development and a career path that allows for upward progress over time are equally important to maintain expertise.

In the United States and European Union, fees support permit staff, and in some cases inspection staff. The scope and amount of fees assessed vary by jurisdiction, but the intent is to provide for a continuous and sustained source of funding over the long-term to maintain a strong permitting program. Fees assessed by China's air quality agencies should be dedicated to the purpose of developing a trained permitting program, and be predictable and certain to ensure long-term program support.