Enhancing the Quality of Issued Air Permits: An Error Rate Analysis

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Introduction

The South Carolina Department of Health and Environmental Control (DHEC) is the state agency responsible for regulating discharges of environmental pollutants. DHEC's Bureau of Air Quality regulates air pollution, and its Air Permitting Division issues permits for the legal discharge of regulated air pollutants, except asbestos, which is handled by a separate section. An air permit is a legal document that specifies the equipment that generates air pollution, air pollution control devices, the applicable regulations, emission limits, emissions monitoring, source testing, recordkeeping, and reporting for a given facility or project. The permit is accompanied by a supporting document called the Statement of Basis. The Statement of Basis contains more technical information about the facility or project, the numerical values for the potential to emit air pollutants, the calculation methods, why regulations are or are not applicable, and the rationale for any source-specific testing, monitoring, recordkeeping, or reporting.

The Air Permitting Division is composed of the Air Permitting Division Director, who reviews and approves air permits for issuance; four permitting section managers who direct the work of the permit writers[1] and review the air permits before they are sent to the division director; three sections with eight permit writers per section, and a fourth section with administrative staff and three permit writers.[2]

[1] The state title is Engineer if the individual is a licensed Professional Engineer or an Engineering Associate if unlicensed. For clarity, they will collectively be referred to as permit writers in this document.
[2] Nominally, actual staffing levels fluctuate.

Problem Statement

In implementing issued permits and incorporating language from previous permits, we find issues with adherence to changes in standardized language and standard operating procedures and guidance for permit content. Moreover, as with any work product, there will be errors and mistakes in issued permits. These issues can range from the relatively benign use of the US customary business and industry abbreviation “MM” instead of writing out the word million to failing to include the correct regulatory language. The resultant impacts being minor confusion, up to having to reissue a permit, which could take days of additional work by the permit writer and other staff.

Although we know these issues exist, we do not have any data on the frequency or distribution of inconsistencies or errors in issued permits. Without this data, our knowledge of the problem and where and how to direct our resources to fix the problem, even if those fixes are working, is based on purely subjective individual observations. Acquiring this data and attempting to take a data-driven approach to improving the quality of our work aligns with DHEC’s core values of *Pursing Excellence* and *Inspiring Innovations*.[3]

Data Collection

From a simplistic view, the data collection would be reviewing issued permits for errors and finding patterns. However, care would need to be taken in developing the methodology for the data to be valuable. The data collection method was broken down into

[3] *About Us | SCDHEC*. (n.d.). Homepage | SCDHEC. Retrieved December 18, 2023, from https://scdhec.gov/about-dhec/about-us

three key aspects: 1) which past permits would be reviewed (the "Permit Universe"); 2) what standardized criteria would be used to identify errors (the "Checklist"); and 3) the variables (e.g., permit type, permit writer's experience).

Permit Universe

Although issuance of permits continued, the work environment during COVID-19's almost exclusively work-from-home period would not be analogous to our current or future work environment, nor would the pre-COVID-19's almost exclusively in-office and face-to-face meetings be to our current mixed or hybrid environment. Therefore, the period selected was the stabilized post-COVID-19 work environment to the present.

After Governor Henry McMaster issued an executive order to begin returning state employees to the office full-time,[4] the Department of Administration approved DHEC's request for an extension to allow time for further planning. Per the approved extension, DHEC was to have all employees reporting to the office by April 5, 2021. To this date, an approximately six-month buffer was added to account for an adjustment period. The timeframe for analysis was October 2021 through October 2023.

As modified permits vary widely in the scale of the modification, any errors found would require a more detailed comparative analysis of previous versions to determine which permit writer made the error. The number of errors made during a modification to a permit is not a good comparison to the number of errors that could be made in drafting a new

[4] Exec. Order No. 2021-12 (2021). https://governor.sc.gov/sites/governor/files/Documents/Executive-Orders/2021-03-05%20FILED%20Executive%20Order%20No.%202021-12%20-%20Modifying%20%20Amending%20Emergency%20Measures.pdf

permit. For these reasons, the analysis was limited to only the first version of a permit. There are other types of work products (e.g., exemptions, relocations, temporary approvals) that were not reviewed as they also vary in the level of review required and thus the potential number of errors. The total number of permits to review was 359. Table 1 presents the Permit Universe by permit type and year issued.

Checklist

Our division's recently created and staffed training position used one manager's list of common errors they identified during permit reviews as a foundation for a larger list to be used for training. That document, plus feedback from the other section managers on items they would like checked, formed the starting point of the checklist. Excluded from the list were items or rules that had not been effective for most of the period reviewed or could not be determined without a more in-depth review.

The final checklist used for data collection had twenty items. For data analysis purposes, the items were categorized as Consistency Issues or ranked on the severity of the error (i.e., Minor, Moderate, or Major). Feedback from the other section managers was also used for categorization. Most items are generally objective; however, there are situations where a subjective decision may be required (e.g., was something explained). In these cases, I tried to be consistent and err on the side of the item being adequately addressed. The nature of the permit contents and the development process preclude using purely objective criteria.

Additionally, the varied nature of the permit contents meant that not all permits would contain each checklist item. Few checklist items are present in all permits. Therefore, the results would be recorded as Acceptable (i.e., the checklist item is present and is correct or acceptable), Error (i.e., the checklist item is present and is incorrect or the checklist item should be present and is not), or Not Applicable (i.e., the checklist item does not apply for this permit). Table 2 present the checklist items, their categories, explanation, and short-hand.

Variables

The variables are information about the permit and how it was developed. They would be used to look for relationships or patterns that may help direct resources to reduce the frequency of errors. There are inherent variables, such as the type of permit issued and the type of error, and variables added for analysis. One of the key additional variables of interest was the years of experience of the permit writer at the time the permit was issued. Another variable suggested for review was which manager reviewed the draft permit.

Other Aspects

To anonymize the data for publication and for the analysis to be as blind as possible given the project design, random numbers were assigned to represent the permit writer, the manager, and the permit number[5] before beginning any plotting or analysis.

[5] The permit numbers include geographical prefixes that can indicate which group of staff probably produced the permit.

Limitations

While the project and data are helpful, the approach's limitations and data must be acknowledged. Each permit that was reviewed is the result of several to potentially a hundred hours of work (in an extreme case), and certainty of the accuracy of the contents could only be verified through a similarly lengthy review of the entire permit record. The checklist results were based on a review of only the permit and the statement of basis. Each permitting authority across the country has wide latitude on how the contents of a permit are presented. Therefore, the results from this project are only comparable to our air permitting program.

Data Analysis

The results were expressed as error rates excluding Not Applicable results (i.e., count of Error results divided by the sum of Error and Acceptable results). Using rates instead of counts accounted for not all checklist items being present in permits and not all permit writers having issued the same number of permits. The overall error rate for all items in the checklist across the permit universe was 8.1%. Errors by category were 7.9% for Consistency, 8.0% for Minor, 10.6% for Moderate, and 4.7% for Major (see Table 3).

Error rates by type and experience required data smoothing to identify trends. The rates were analyzed using one-, two-, three-, four-, and five-year bins for years of experience. Five-year bins provided the smallest bins that did not require the exclusion of a bin due to their small sample size. Figure 1 plots the error rate by type and years of experience. The data did not exhibit strong relationships between error rates and years of experience. The

only identifiable trend was that after the rate of consistency errors hit its lowest point at 5-10 years of experience (1.9%), the rate steadily rose until it peaked at 25-30 years of experience (10.9%). I hypothesize this is because most of the Consistency items are recent changes to long-standing naming conventions and procedures.

For ease of comparing permit writers, a weighted composite error rate was created with Consistency errors weighted 5%, Minor 15%, Moderate 30%, and Major 50%. Figure 2 plots the composite error rate by permit writer. There was significant variation between permit writers with minimum, average, and maximum values of 0%, 15.8%, and 32.8%.

Detailed error rates by category per manager are presented in Table 5. Figure 3 plots the weighted composite error rate. The managers showed substantially less variation than the permit writers. However, the data still presented a large gap between the minimum composite error rate of 4.8% and the maximum of 11.1%. Comparing just the high sample size managers (IDs 39, 71, 99), the composite rates were 9.8%, 4.8%, and 6.9%, respectively.

Interviews of the managers found that they did not utilize a checklist when reviewing permits. A notable exception is manager ID 71, who had developed the list of common errors mentioned in the checklist development discussion. Manager ID 71 had the lowest composite error rate, but as the common errors list had only been used as a reference for staff and not implemented as a checklist to be used with each review, the error rate could be reduced.

The potential solution to the problem of these error rates is to implement a division-wide checklist that all permitting managers enforce. In addition to reducing the error rates,

implementing the checklist as a division-wide standard should increase consistency between the managers.

Implementation Plan

Using the checklist developed for this project and the list developed by our trainer as a starting point, the permitting management team should discuss, review, and adopt a division-wide checklist that both the permit writers will use in reviewing their work prior to submission to the manager for review and the permitting managers in their reviews. Each permitting manager should solicit feedback from their permit writers (key stakeholders) on the items in the checklist and potential causes for the errors. Care should be taken to balance the usability of the checklist (e.g., number of items) with the need for thorough error checking.

Such a checklist could be implemented quickly (one to two months) and with negligible cost. The permitting management team should be able to discuss, review, and adopt a division-wide checklist within a couple of weeks. Each permitting section meets at least monthly, and this type of change would best be discussed at a section meeting. The open dialogue nature of the section meetings will facilitate discussion and provide valuable feedback. Depending on whether the feedback identifies any significant flaws in the implementation of the checklist, it may be implemented within that month or the next.

Each permit already undergoes permitting section manager review prior to issuance. Based on the time needed to generate the data for this project, the twenty-item checklist

averaged 3 minutes per permit, which is a negligible amount of additional time for permit reviews.

Evaluation Method

Properly implemented and enforced by the permitting management team, the errors on a developed checklist should be all but eliminated in issued permits. Evaluating the checklist's effectiveness in reducing the overall error rate using a data-driven approach is problematic. The checklist will be an evolving document, and presumably, the same checklist used during the draft permit reviews will be used to check for errors in the issued permits. A review of issued permits for specific checklist items after new checklist items are added and some time has passed (e.g., six months) would provide data on whether adding the checklist item effectively eliminates that type of error. This narrow scope of review and a broader scope of review, like the collection method used in this project, may be helpful to identify any potential differences or issues in implementation, such as the ability to identify the errors consistently and accurately, take corrective action, etc. by different permit writers and managers.

Summary and Recommendations

This project found that a checklist of common errors could be used to quickly identify errors during draft permit reviews, significantly reducing the number of errors in issued air quality permits. Reducing errors can range from relatively benign to major errors of missing the correct regulatory language. The checklist should be able to be implemented swiftly, with negligible additional time required per draft permit review and with existing resources. It is

recommended that this checklist be developed and implemented by the air permitting management team.

Appendix A – Data Collection

Table 1

Permit Universe

Permit Type	Year			Total
	2021	2022	2023	
Construction				
Minor				
Expedited	13	29	26	68
Non-Expedited	6	48	21	75
Synthetic Minor				
Expedited	0	7	7	14
Non-Expedited	4	11	16	31
PSD	0	5	4	9
Operating				
State				
New	3	8	17	28
Renewal	4	12	16	32
Conditional Major				
New	2	8	4	14
Renewal	2	3	3	8
Title V				
New	0	8	6	14
Renewal	8	41	17	66
Total	42	180	137	359

Note. Time period is October 2021 through October 2023. Expedited and Non-Expedited PSD construction permits were consolidated due to small sample size (non-expedited $n = 1$; expedited $n = 8$).

Table 2

Checklist

Category	Item	Short-Hand
Consistency	Including a tenths place on numerical synthetic minor limits (i.e., x.0)	Tenths Place
	Writing out less than instead of using the symbol	Less than
	Writing out the word million instead of MM or 10^6	Million
	Listing "None" for control device instead of "N/A"	CD None
Minor	Type of construction permit indicated on the front page is correct	Front Page
	Equipment Exhaust IDs match modeling Stack IDs	Exhaust IDs
	Correct operational flexibility conditions are used based on whether the State OP or Conditional Major is a lifetime permit or not.	OP Flex
	Numeric Std 5.2 limit is in the permit (e.g., not 30% reduction).	Std 5.2
	NESHAP table does not have "Contact Air Toxics" or other errors	NESHAP Table
	Construction statements of basis list what type of modification will be required to incorporate the construction permit into the operating permit.	OP Revision
	The purpose and/or origin of special conditions are explained in the Statement of Basis	Special Explained
	A list and/or explanation for all stack testing is in the Statement of Basis	Stack Test
	The single source determination is in the SOB or the SOB states where it may be found	Single Source
Moderate	For State OP or Conditional Major permits which are not lifetime permits, the statement of basis explains why.	Lifetime Explain
	For all sources that combust fuel, there is a condition that specifies what fuels may be combusted.	Fuel Condition
	Where parametric monitoring is required by a permit, the two general parametric monitoring conditions are present.	Parametric General
	Where parametric monitoring is required by a permit, the appropriate range language is present.	Parametric Range
	The Statement of Basis addresses all regulations that are present in the permit.	SOB Regs
Major	For construction permits, the correct certification language is present.	Certification
	All applicable regulations are in the permit.	Permit Regs

Appendix B – Data Analysis

Table 3

Overall Results

Checklist Category	Data Points	Acceptable	Error	Error Rate
Consistency	710	654	56	7.9%
Minor	1,421	1,307	114	8.0%
Moderate	881	788	93	10.6%
Major	555	529	26	4.7%
Total	3,567	3,278	289	8.1%

Table 4

Error Rates by Type

Error Type	*n*	Error	%
Consistency			
Tenths Place	139	6	4.3%
Less than	140	2	1.4%
Million	155	38	24.5%
CD None	276	10	3.6%
Minor			
Front Page	197	2	1.0%
Exhaust IDs	316	24	7.6%
OP Flex	81	0	0.0%
Std 5.2	73	6	8.2%
NESHAP Table	263	2	0.8%
OP Revision	194	49	25.3%
Special Explained	119	18	15.1%
Stack Test	117	10	8.5%
Single Source	61	3	4.9%
Moderate			
Lifetime Explain	15	3	20.0%
Fuel Condition	178	34	19.1%
Parametric General	172	32	18.6%
Parametric Range	157	22	14.0%
SOB Regs	359	2	0.6%
Major			
Certification	196	19	9.7%
Permit Regs	359	7	1.9%

Figure 1

Error Rate by Years of Experience

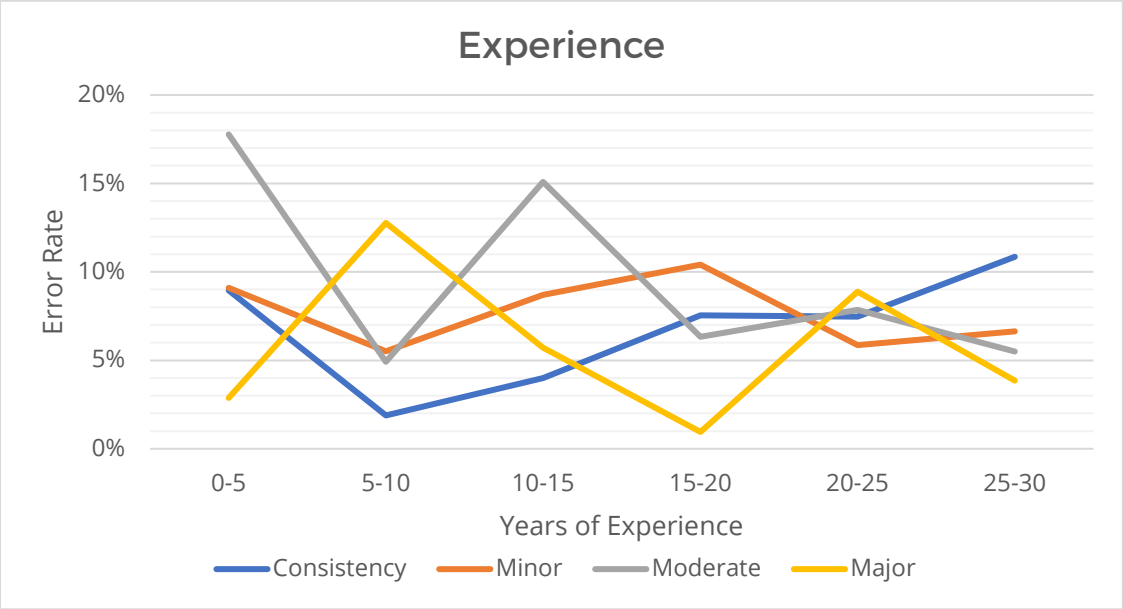
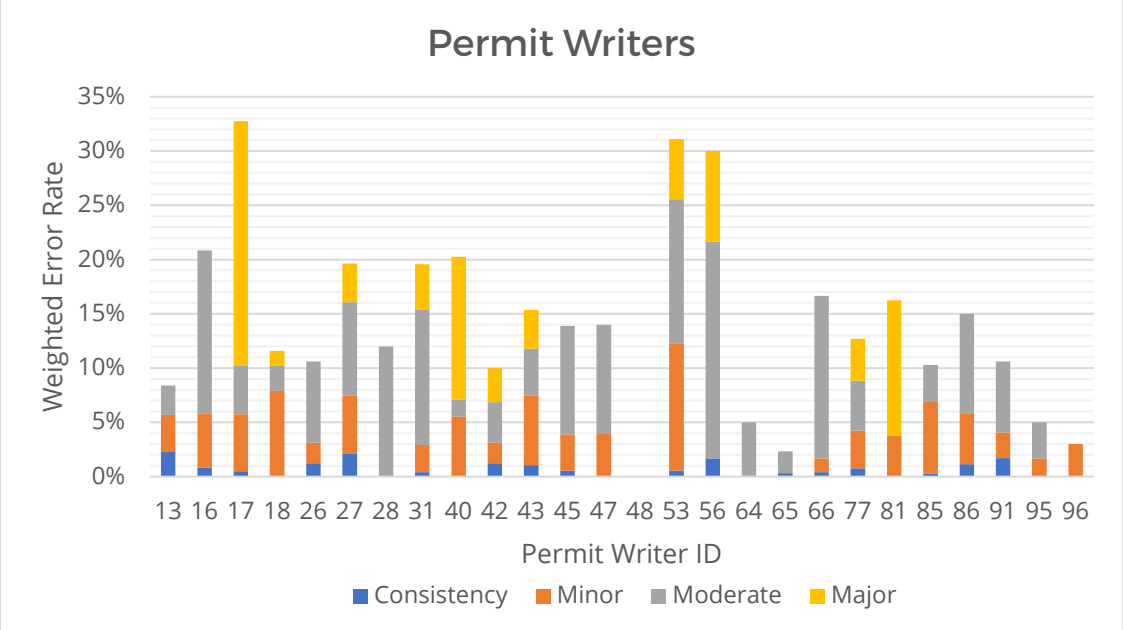


Figure 2

Weighted Composite Error Rate by Permit Writer



Note. Error rates were weighted 5% Consistency, 15% Minor, 30% Moderate, 50% Major. Permit Writer IDs 14, 44, and 78 were excluded; each had < 5 permits.

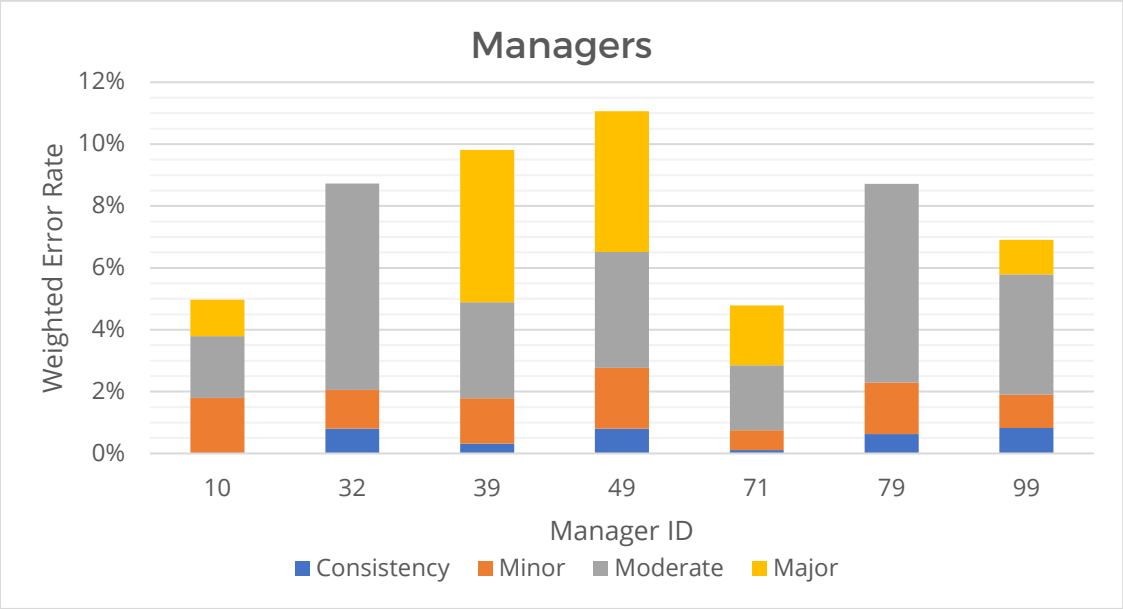
Table 5

Error Rates per Manager

Category	Manager ID						
	10	32	39	49	71	79	99
Consistency							
n	102	31	173	25	180	16	183
Error	0	5	11	4	4	2	30
%	0.0%	16.1%	6.4%	16.0%	2.2%	12.5%	16.4%
Minor							
n	201	48	337	61	398	27	349
Error	24	4	33	8	17	3	25
%	11.9%	8.3%	9.8%	13.1%	4.3%	11.1%	7.2%
Moderate							
n	105	36	203	40	229	14	254
Error	7	8	21	5	16	3	33
%	6.7%	22.2%	10.3%	12.5%	7.0%	21.4%	13.0%
Major							
n	85	16	132	22	155	10	135
Error	2	0	13	2	6	0	3
%	2.4%	0.0%	9.8%	9.1%	3.9%	0.0%	2.2%
Overall							
n	493	131	845	148	962	67	921
Error	33	17	78	19	43	8	91
%	6.7%	13.0%	9.2%	12.8%	4.5%	11.9%	9.9%

Figure 3

Weighted Composite Error Rate by Manager



Note. Error rates were weighted 5% Consistency, 15% Minor, 30% Moderate, 50% Major. Manager ID 79 excluded. Manager IDs 32 and 49 have substantially lower sample size than the rest.