Quality Management for CCR Storage Facility
Construction, Operations, and Closure

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ABSTRACT:
Across the coal ash industry, large-scale facilities are constructed to store CCRs in support of our nation’s power supply. These engineered facilities require robust monitoring during construction to verify that the design intent is met to minimize risk to the facility and surrounding environment.

Key components of any quality management program include the means for the collection, reduction, and interpretation of monitoring data. Field verification of engineering criteria, along with calibration of the construction technique and associated monitoring through appropriately scaled activities, is required. Logistics must be established for seamless team networking, coordination of project activities, implementation of learned lessons, record documentation, etc.

This paper does not document a case study, but rather a generalized framework for a proven quality management approach for the construction, operations, and closure of CCR storage facilities. Our experience is based on multiple projects, including the landfill constructed for the TVA Kingston Ash Recovery Project.
THE ISSUE

Quality is a subjective attribute that can be interpreted differently by different individuals. To be effectual, quality can be better characterized as defining expectations and then meeting them.

Multiple stakeholders, each with their own expectations, are challenging the coal ash industry on the effectiveness of coal combustion residual (CCR) storage. At the root of this challenge, lies concern of whether storage facilities are constructed to meet expected (or in cases, required) performance standards. Little to no documentation may exist that defines the as-built condition and offers objective proof that engineering criteria were satisfied during construction.

Recent facility failures, resulting in the release of stored CCRs, have driven federal initiatives to regulate the coal ash industry and achieve a more consistent definition of “quality management” to address this issue. The basis for determining that expectations are met for new facilities will initially be made in design (verified through individual state permitting processes) and then carried forward to all aspects of construction (i.e., the life cycle of a facility), including site development, foundation construction, storage operations (or embankment construction, where applicable), and closure. Well-structured and documented efforts that demonstrate compliance with permitted conditions are needed.

THE SOLUTION

While the individual components of a quality management program will (and should) vary for different facilities, the program must be structured to provide for the collection, reduction, and interpretation of monitoring data necessary to verify the design intent. The design intent is established through engineering criteria for a subject activity, which typically include:

- Constructed configuration and properties;
- Acceptable materials for use in construction;
- Protocols for material placement;
- Type and frequency of material sampling;
- Type and frequency of material testing;
- Type and frequency of field measurements;
- Type and frequency of field observations; and
- Documentation requirements.
The Owner serves a pivotal role in any quality management program by procuring qualified individuals to conduct defined roles, establishing the tone to which each of these individuals work with each other, and holding individuals accountable. Roles include various levels of management, along with quality control/assurance and associated support. External interest in the program will vary, but could include permitting agencies, public entities, etc.

Efforts to promote robust monitoring must be deliberate. All individuals should strive to understand the importance of the program and contribute toward its success. Training and seamless team networking will facilitate reaching this goal. Clear lines of communication should be established, with dedicated channels in-place for critical activities. Routine means to assess and calibrate the effectiveness of the program should be pursued.

PROGRAM FRAMEWORK AND LOGISTICS

The attached flowchart outlines a generalized framework that defines the primary quality management tasks and sequence of activity, necessary to verify the design intent. The framework places emphasis on two primary processes: quality control (QC), and quality assurance (QA).

While design defines specific engineering criteria that will be used for the basis of acceptance, it does not provide the means for the collection, reduction, and interpretation of monitoring data. Depending on the complexity and variability of a constructed element, along with its design function, establishing appropriate means that will satisfy all stakeholders may prove difficult.

Being transparent by engaging stakeholders (early and often) will facilitate consensus. Stakeholders want to understand the details of monitoring and whether the program is objective and conforms to industry standards and best practices. Where critical, consider third party assessment (or peer review) of the program.
Generalized framework defining primary quality management tasks and sequence of activity.

Conduct Quality Assurance to verify that program is meeting its objective and to promote opportunity for improvement (incorporate learned lessons, etc.).

to verify that constructed elements meet engineering criteria through quantitative (sampling, testing, and measuring), and qualitative (observing) means.

Recommend Acceptance
QUALITY CONTROL (QC)

The QC process uses both quantitative and qualitative means to assess quality. While quantitative means (sampling, testing, and measuring) yield more objective results when compared to qualitative means (observations), these may not always be practical. Because results are extrapolated across a larger population size, care must be exercised to select representative samples. Sample types are generally classified as either disturbed or undisturbed, and consist of bulk materials (where specimens are obtained for testing) or discrete specimens that are tested directly. Protocols must be established to preserve sample integrity during its removal, transport, storage, and testing. Industry standards and best practices should be followed to meet this objective.

Testing is accomplished in the field and the laboratory. Results may be used to pre-qualify materials for use in construction, establish required placement criteria (e.g., moisture-density relationships), or verify constructed properties.

Means to validate results should be pursued for critical activities. These may include using different testing procedures and/or devices to verify that consistent results are achieved (i.e., accurate and repeatable).

In cases where indirect testing methods are used, results should be compared to those obtained by direct methods. The goal is to verify that indirect testing protocols are adequate and that devices are calibrated appropriately.
Field measurements are made to verify the constructed configuration. These typically include surveying (using both aerial and ground methods) and/or other related techniques for elements constructed above grade, and soundings for elements constructed below grade. While design configurations are presented in “neat” dimensions, practical construction techniques tend to result in as-built conditions that are more irregular. Additional measurements may be necessary to obtain sufficient data to verify that the desired configuration is achieved.

Observations, while subjective, provide an opportunity for “continuous” monitoring by filling the gap between scheduled sampling, testing, and measuring activities. Results may be used to identify non-standard construction techniques and/or unexpected conditions; both of which may indicate the need for additional quantitative assessment.

Consistent and timely means to reduce QC data must be established. Results need to be reported in a clear, concise format. Depending on the complexity of the construction activity, electronic means to reduce data may be needed to facilitate this goal.

QC data is compared to engineering criteria. If criteria are met, results are documented and recommendations are made for acceptance. In cases where criteria are not met, the design team will need to determine whether mitigation is required. If mitigation is required, the QC process is repeated for the additional construction.

Beyond the comparison of discrete data to criteria, the team should also consider any consistent trends across larger population sizes. These may facilitate definition of appropriate mitigation (by placing emphasis on the “whole” rather than a “part”), identify the need for more monitoring, etc.

**QUALITY ASSURANCE (QA)**

The QA process is intended to promote stakeholder confidence that construction satisfies the design intent. This is accomplished through routine assessment and calibration.

Independent verification of critical activities, along with calibration of the construction technique and associated

*Field calibration of varying construction techniques to facilitate monitoring.*
monitoring, is required. This provides the opportunity to assess whether standard practices are adequate and incorporate any learned lessons. Appropriately scaled test sections (or field demonstrations separate from construction) may be necessary to facilitate these efforts.

Key team members should support this effort to provide a comprehensive, first-hand assessment of the program.

Consideration should also be made to solicit independent assessment from qualified third-parties not involved with the project. This will offer a “fresh” perspective on standard practices and facilitate consensus on critical activities.

SUMMARY

Quality is a subjective attribute that can be interpreted differently by different individuals. To be effectual, quality can be better characterized as defining expectations and then meeting them.

Multiple stakeholders, each with their own expectations, are challenging whether CCR storage facilities are constructed to meet expected (or in cases, required) performance standards. Robust monitoring is required during construction to verify that the design intent is met and stakeholder interest is satisfied.

We have found that the approach outlined herein, when calibrated to meet specific project needs, serves as the first step to provide an objective and transparent path forward.