ISSUE 2 • 2024

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Applications, Science, and Sustainability of Coal Ash

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Table of Contents

Let's Continue the Conversation

By John Halm, ACAA Chair

This was supposed to be a straightforward editorial, as my term as Chair is ending and this will be my last message in this forum. Easy … just thank people for their assistance and encourage others to participate in the association, supporting our mission and persevering through the regulatory and environmental uncertainty that has dominated our business for well over a decade now.

And then there was this presidential election.

The political balance of power shift, with an incoming Republican White House along with majority control over both houses of Congress, has inflated "uncertainty" to new levels. Many believe that this will usher in a new era with a return to a more reasonable response to environmental stewardship and science-based legislation that most average people would call common sense. This all seems like such a clean slate to start from, it's exciting to think about what our perfect world might look like:

- Energy policies that balance safety, the environment, and economics and expand reliable power needed for continued growth and competitive dominance.
- Safe development of energy source technology with realistic plans to develop, deploy, and operate a new generation based on science and business management practices.
- Balanced approach to manage natural and stored resources to improve the economy and permanently solve environmental issues.

The expectation is that with the pendulum of power shifting so much, a move from policies that appear extreme at times will now be based on thoughtful legislation that will benefit everyone. I have been asked for insight into what the Trump administration means for the utility industry and byproducts more times than I can count since the election, and the truth is, like everyone else, I don't know. The reality is that the pendulum never stops swinging, and sooner or later we will return to a fundamental basis of what drives everything. To quote a phrase coined by James Carville that is too often repeated: "It's the economy, stupid."

While our association's focus is on coal combustion product management and use, the Trump administration's America First energy policy has clearly identified energy independence as the core priority. The capital needs for power generation over the next several decades are staggering and increasing exponentially due to shifts to electrify as much as possible, including vehicles and data centers supporting cloud storage and AI. The debate over coal's future will also be shaped by market forces. Regardless of any legislative support, the coal industry will continue to struggle against the economic reality of cheap natural gas, renewable energy, and declining demand for coal in global markets. The world is looking to shift to electricity and to the power producers to solve the larger fossil fuel environmental issues by moving to renewable technology that does not exist in an adequate state today. We simply don't get where we need to be without electrification.

Whatever form this takes in the future, regulatory certainty is the key for prudent financial investment, with the cost of poor decisions unacceptably high. If coal ash legislation is in the way of energy growth, I think it is reasonable to assume that the new administration will take legislative steps to modify current ash management and effluent regulations that are expensive and have negligible benefit to the environment. In line with the broader trend of transferring power from federal agencies to state governments, the Trump administration may push for more state-level control over CCP management and beneficial use. This could lead to a more fragmented regulatory landscape, where states with stronger coal industries are permitted to implement more lenient policies, while those with stricter environmental protections might impose greater controls.

Access to capital drives change through investment, and these fundamentals are unlikely to shift despite legislative belt loosening. The bottom line is that our mission doesn't change. My

hope is that we can achieve some incremental gains that help support our mission to advance the management and use of coal combustion products in an environmentally responsible, technically sound, and commercially competitive manner.

Beneficial use provides an alternative to long-term storage that permanently removes coal byproducts from the environment, with success dependent on having enough time, storage, and logistical support. Our organization has supported the development of uses for these materials over the past 56 years and continues to support creation of new technologies and processes to utilize previously stored material. The evolution over the past decade to byproduct harvesting from basins and landfills is maturing, with use exceeding over 50 percent in some regions and continuing to grow as production supply continues to decline. In addition to solving issues for the power industry, the use of these products has become key to the cement and concrete industry's sustainability and carbon reduction goals.

In short, while we may see some gains from modified legislation regarding coal byproduct management, the overarching issues of growth, investment demands, and access to capital make returning to the coal-burning world of a decade ago unrealistic. The simple truth is that our nation remains increasingly polarized in a non-trusting and suspicious environment, with everyone seeming to talk/shout and no one really listening. I was struck during a conversation with an environmentalist at WOCA 2024 that ended with "let's continue the conversation." The reality is that there really isn't any intent to have a conversation; just pose arguments and expect the other party to shift their position. My expectation is that all we will do is continue the frustration on both sides, but I try to stay positive and maintain hope that we can find middle ground through trust and respectful dialogue.

I believe everyone expects CCR legislative activities to develop quickly as the new year begins, and I recommend that ACAA members listen in on John Ward's monthly Government Relations Committee calls to stay current with events. His forum is open to all members and provides one of the best values for the association. His knowledge and insight will be extremely helpful to better understand legislative drivers and pending changes. The call is normally scheduled for the first Thursday of the month; please contact Alyssa Barto if you need a calendar link.

As I mentioned at the start, this is my last editorial message from the Chair position. Prior to my involvement as Vice Chair and Chair, I had minimal involvement, or frankly interest, in the administration of the association. I have been pleasantly surprised to find that involvement has expanded my knowledge and appreciation of the organization and generated relationships that I wouldn't have otherwise. For myself, I find that the greatest value of this organization is networking. Personal involvement provides so many benefits that I didn't anticipate, and I feel that I received more than I put in. I encourage anyone considering committing the time to support the association to take a chance and look for ways to involve yourself with committees or officer positions; I believe that you will be surprised where some of the relationships take you. We are an organization of volunteers and should all endeavor to play an active role in it.

Lastly, I want to thank everyone for their support during my tenure, including the board of directors, committee chairs, Tom Adams, Alyssa Barto, and John Ward, who do a great job leading and representing our association. Special thanks to the Executive Committee with Tom Kierspe and Christine Harris who, along with Steve Benza as Past Chair, have worked tirelessly and been a great sounding board—always willing to provide an ear and advice. I look forward to continued involvement in the Past Chair position and helping lead the association into the future. I wish you all a happy, healthy, and prosperous new year.

Our Time

By Thomas H. Adams, ACAA Executive Director

The election on November 5, 2024, is in the books, much earlier than I expected after the debacle of 2020. In that election, counting of the votes dragged on and on. Courts were heavily involved. Donald Trump insisted that the election was stolen from him and the Republican Party. I think most Americans are thankful the country is not going through that experience again.

We now have clarity on who will be managing the country for at least the next two years. The Presidency and U.S. Congress will be under Republican control, as was the case in 2017 and 2018. However, unlike 2017-2018, it appears there will be less chaos in appointments and action agendas. In the first Trump administration, appointments and actions were not defined on day one. The second Trump administration is starting out much differently.

For ACAA, this is a time for action to get some issues settled. In discussions with other beneficial use stakeholders, we are seeing great interest in moving quickly to act on topics that have been ignored or mismanaged under the Biden administration. However, we are under no illusion that the Environmental Protection Agency staff will suddenly be more amenable to CCR beneficial use issues. We will be working to have the new EPA administrator direct staff to resolve some issues that have been allowed to go unresolved.

ACAA will be on the ground in Washington, D.C., starting in early 2025 to advocate for changes that are needed to defend and grow beneficial use. The centerpiece of those discussions will be the success of ash harvesting and the importance of growing that activity to achieve increased durability of concrete and lower the carbon footprint of concrete construction.

We invite all ACAA members to be involved. The best and easiest way to get current information is to participate in the Government Relations Committee calls. Chair John Ward has announced that the calls will increase from once per month to twice per month as activity by ACAA and other stakeholders is ramped up.

Given that we will have much improved access and attention from federal officials in 2025, it is clearly our time to act on behalf of our mission.

* * *

As this issue of *ASH at Work* is published, we want to take time to thank all ACAA members for a very successful 2024 and convey our best wishes for a successful 2025. There are many challenges and opportunities facing our industry, country, and world in the coming year. We look forward to working with you to deal with those challenges and opportunities. Happy New Year!

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Rumors of Coal Ash's Demise Are Greatly Exaggerated

The rapidly expanding practice of "harvesting" previously disposed ash ensures ample supplies for decades to come

By David Cox, P.E. and John Simpson

For decades, fly ash has been the supplementary cementitious material (SCM) most commonly specified to improve concrete performance in the United States. The first ASTM standard for coal fly ash—C35011—originally published in the mid-1950s, was subsequently combined with a specification for natural pozzolan and the designation changed to C618 in 1968.[1] And while the beneficial properties that fly ash imparts to both fresh and finished concrete are now well understood, its widespread adoption in the U.S. came only after experimentation with a range of other pozzolans.

Concerned with both the cost and the potential for deterioration in mass concrete placements that used only portland cement as a binder, early U.S. hydroelectric dam builders of the 1930s investigated a number of other cementitious additives, including pumicite, calcined clay, and even diatomaceous earth.[2] In 1949, in what is generally regarded to have been the first major U.S. infrastructure project to use fly ash on a wide scale, engineers incorporated 120,000 metric tons of fly ash[3] to replace 32 percent[4] of the cement in the concrete mix of Montana's Hungry Horse Dam—which today still stands as one of the largest concrete-arch dams in the country.

Engineers found that not only was fly ash—which had to be sourced from Chicago and transported 1,600 miles—a cheaper substitute for portland cement, but it also improved the concrete mix's workability, lowered requirements for water, and reduced both the heat of hydration and the accompanying risk of thermal cracking.[5] More than 60 years after its construction, concrete samples taken from the dam were tested for alkali-silica reaction—a deleterious chemical interaction that can cause concrete expansion and cracking—and proved fly ash's long-term effectiveness in combating this condition as well.[6]

In the 75 years since the dam's construction, hundreds of millions of tons of fly ash have been used to capture these economic and performance benefits in concrete projects throughout the U.S., ranging from dams to highways, bridges, buildings, pipelines, tunnels, and more. More recently, however, as the risks associated with climate change have become more apparent, fly ash's utility in helping reduce concrete's carbon footprint has assumed new importance.

A Changing World ... for Climate, Concrete, and Coal Ash

Today, concrete is the world's most popular building material, with an estimated 30 billion tons produced globally each year to supply the construction industry.[7] The material's many virtues—it is strong, durable, water- and fire-resistant, low maintenance, and economical—ensure that it will continue to play an outsized role in construction for decades to come. The International Energy Agency projects that global concrete production will increase between 25 and 50 percent by 2050.[8]

But the downside to this growth is that concrete production generates approximately 8 percent of all man-made CO2 emissions—almost all of which accrue from the manufacture of portland cement, one of concrete's principal components. Each ton of fly ash used *in place* of traditional cement, however, yields a reduction of just under one ton of carbon dioxide released into the atmosphere.[9]

If concrete is to be decarbonized in any significant measure to help alleviate its emissions problem, SCMs such as fly ash must displace the use of portland cement at a significantly greater rate than is now the case. And yet the need for more fly ash comes as the coal plants that produce it continue to be retired. This is a problem, right? Wrong.

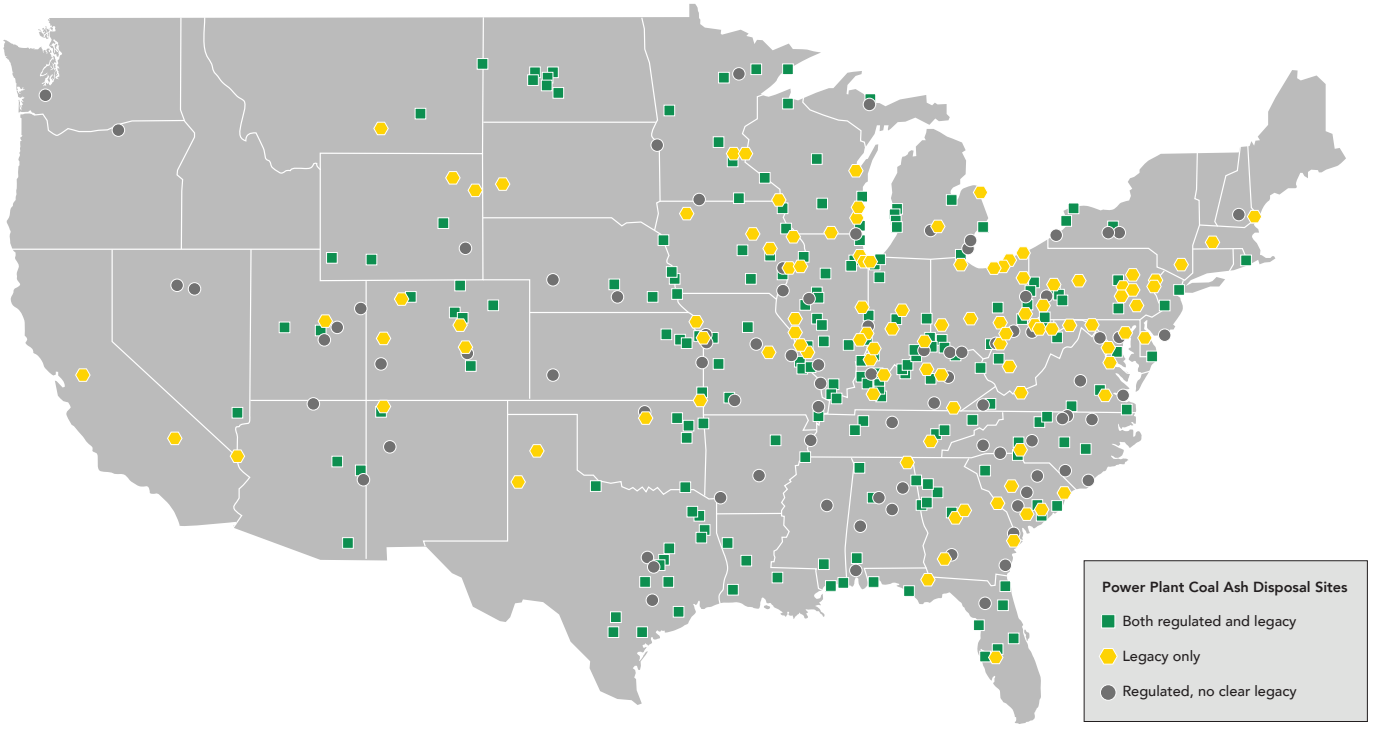
The Rapidly Growing 'Harvesting' Universe

While the number of coal plants indeed continues to shrink, the U.S. nonetheless still disposes of vast amounts of high-quality fly ash each year. In 2022, the last year for which data is available, 11.4 million tons of fresh fly ash—over 40 percent of that produced—was disposed.[10] That same year, more than 4 million tons of previously disposed coal ash was harvested and utilized in concrete as well as a variety of other applications—the equivalent of 8.7 percent of the volume of ash recycled from current power plant operations.[11]

And there's plenty more where that came from. The American Coal Ash Association estimates that there are approximately 2 billion tons of previously disposed coal ash in landfills and surface impoundments located throughout the U.S. (see map of disposed ash locations below). To help visualize the *weight* (if not the volume) of previously disposed ash, NASA estimates that 2 billion tons is equivalent to 20,000 fully loaded aircraft carriers.

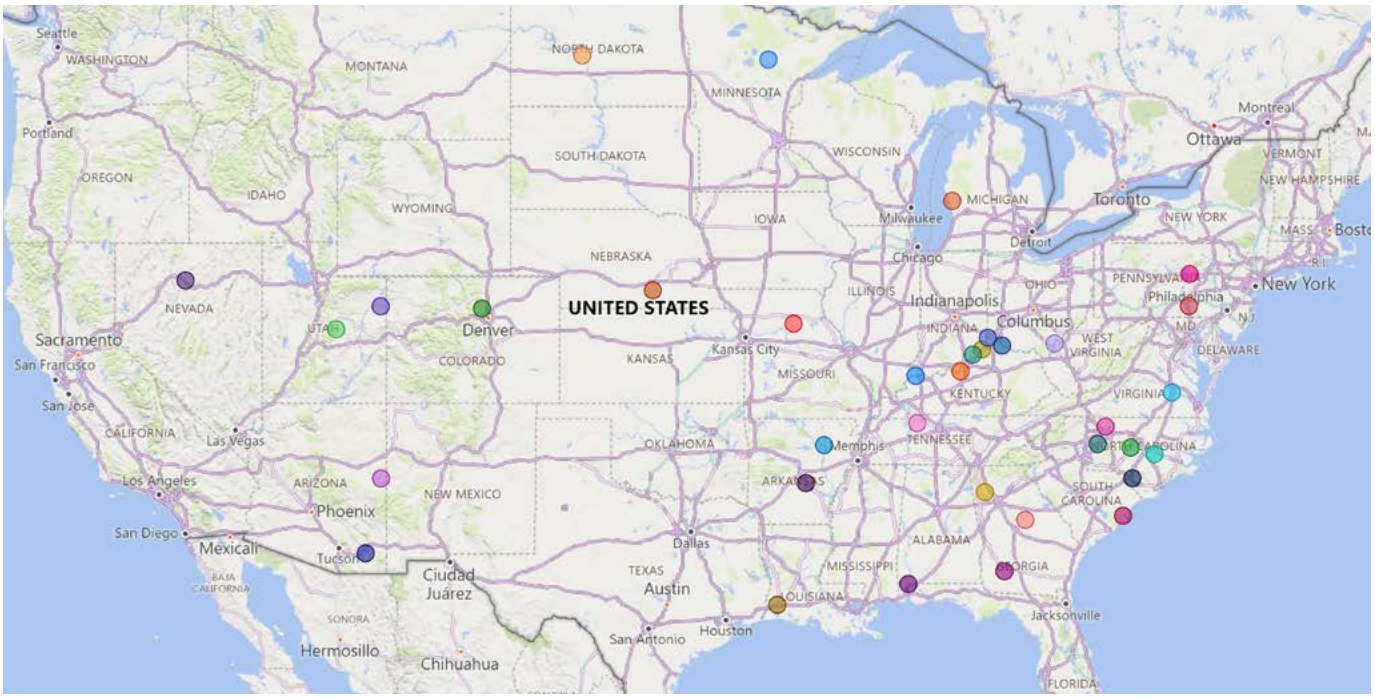
Harvesting this ash requires significant infrastructure to excavate, screen, dry, process, and beneficiate it in preparation for market. This infrastructure is already being built out, with more than 20 commercial-scale projects currently operating in every region of the country (see map of harvesting project locations on page 8).

Power Plant Coal Ash Disposal Sites



Finally, consensus standards are required to establish a framework for the effective characterization and responsible harvesting of previously disposed ash for beneficial use. Stakeholders from ACAA and other interested parties have worked with ASTM International in recent years to produce two standards (ASTM E3355 and ASTM E3183, respectively) in support of these activities.[12]

Ash Partnerships for Beneficiation of Ponded/Landfilled Ash



A Range of Beneficiation Technologies

Commercial technologies now in use for beneficiating previously disposed fly ash vary, depending on the condition of the ash and the nature of the treatment required to bring it up to ASTM standards for use in concrete production and other applications. These techniques include chemical treatment, electrostatic separation, carbon burn-out, and other proprietary methods:

- *Carbon Burn-Out*—In this process, residual carbon in fly ash is combusted, which produces a low-carbon, low-loss-on-ignition, high-quality pozzolan.[13]
- *EnviroSource® Fly Ash Beneficiation Technology*—This is a thermal process that reduces loss-on-ignition, ammonia, and moisture in dry and wet fly ash.[14]
- *Electrostatic Separation*—This process uses triboelectrostatic charging to separate high-carbon and low-carbon ash particles, yielding a higher-quality fly ash stream.[15]
- *STAR® Technology*—This thermal beneficiation process was the first technology in the world to be used on ponded ash on a commercial scale.[16]

The cumulative result of all these technologies, however, is to allow utilization of a much broader spectrum of ash qualities than existed in the "fresh ash only" era. (See sidebar on page 10 with examples of commercially operating harvesting projects utilizing an array of these technologies.)

Public Policy Helping Drive Harvesting

It should be noted that part of the impetus to develop beneficiation technologies for harvested ash has come from government and regulatory bodies. The U.S. Environmental Protection Agency has been supportive of coal ash beneficial use for decades and notes on its website that "beneficial use of coal ash can produce positive environmental, economic, and performance benefits such as reduced use of virgin resources, lower greenhouse gas emissions, reduced cost of coal ash disposal, and improved strength and durability of materials."[17] More recently, evolving EPA regulations are increasingly prohibiting "closure in place" strategies for ash landfills and surface impoundments.

At the state level, policymakers in Virginia and North Carolina have specifically mandated excavation of coal ash from ponds and landfills in several instances and approved plans to beneficiate the ash for market sale. In 2019, the Virginia General Assembly passed legislation mandating the removal of ash from Dominion Energy surface impoundments to landfills, as well as for a portion of the ash to be recycled.[18] That same year, the North Carolina Department of Environmental Quality instructed Duke Energy Progress LLC to excavate coal ash impoundments at six sites throughout the state.[19] Duke Energy now operates STAR® Technology facilities at three sites that will allow it to recycle more coal ash in the Carolinas than it produces annually from power plants (see sidebar on page 10).[20]

Onward and Upward

Because most harvested materials require beneficiation, they are of a more consistent quality than much of the "fresh" ash that users have sourced directly from the power plant over the past decades. Moreover, owing to the fact that harvesting operations are not dependent on an operational power plant to generate ash, this supply is more reliable than that of fresh production ash. Collectively, these two factors will allow

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concrete specifiers, producers, and users access to greater volumes of coal ash going forward than they have historically been accustomed.

As previously noted, if the concrete sector is to make real progress decarbonizing its products, SCMs such as fly ash must displace the use of portland cement at significantly higher rates than they do currently. If, for example, U.S. concrete producers were to double their current usage of fly ash—from 11 million tons to 22 million tons—the existing supply of previously disposed ash (2 billion tons) would last for over 90 years. And that supply is independent of the additional volumes that would be generated by coal power plants that continue to operate in the interim.

While it is a paradox that the closures of coal-fueled power plants have resulted in deployment of strategies that will provide access to more and better ash, it is one that the concrete industry must take advantage of if it is to decarbonize expeditiously in the decades ahead.

David Cox *is the founder of FirmoGraphs LLC, a business intelligence and data science firm specializing in the North American utility and industrial markets. He holds BS and MS degrees in civil and environmental engineering and is a professional engineer in the state of California. His background includes engineering, consulting, marketing, and sales work in utilities and heavy industry.*

John Simpson *is editor of ASH at Work.*

Commercially Operating Harvesting Projects

Currently operating ash harvesting projects in the U.S. utilize an array of beneficiation technologies, including the following:

- For the past five years, Eco Material Technologies has harvested Class F fly ash from a monofill in Montour County, Pennsylvania. Chemical and physical analyses of the ash, which was stored in a covered 30-acre site above natural grade, determined that the ash requires comparatively little beneficiation. Ash is being extracted from the landfill, screened, and fed into a rotary dryer for moisture reduction, whereupon it is further processed for fineness to ensure consistency prior to being made available for beneficial use in concrete and other applications.[21]
- Since 2015, Santee Cooper's Winyah Generating Station has used The SEFA Group's Staged Turbulent Air Reactor (STAR) technology to reclaim and beneficiate coal ash from on-site ponds. Ash is excavated, screened, and then fed into the STAR unit's external heat exchanger, after which the material is processed at high temperatures to remove excess carbon. After cooling, the processed ash is moved to a storage silo, where it is loaded into airtight pneumatic tankers for delivery to concrete producers. STAR facilities now process harvested ash at three additional sites in North Carolina.[22]
- Since 2021, Salt River Materials Group has been harvesting and beneficiating fly ash from an onsite landfill at the Coronado Generating Station in St. Johns, Arizona. Using fly ash drying, screening, and classifying equipment, the project generates an additional 300,000 tons per year of ASTM C618 concrete-grade Class F fly ash for distribution into SRMG's fly ash supply network.[23]

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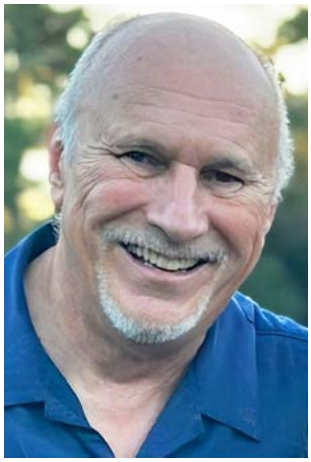

Joe Laubenstein

Waste Connections is fully committed to continuing its service to the coal ash management and beneficial use sectors. We welcome **Josh Savant** to fill Joe's large shoes. Josh brings over 20 years of executive experience in the industrial sector, including five years at Waste Connections, and is eager to build on the success of our CCR residuals program.

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Recycling and disposal of construction and demolition waste, as well as management of on-site coal combustion residual material.

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The Next Generation of SCMs: A Look at the Contenders and the Pretenders

By Bruce Parker

Each year, the list of "stuff you can put in concrete" to lower its carbon footprint grows. For many decades fly ash harvested from coal-fueled power plants has been the leading supplementary cementitious material (SCM) used to replace a portion of ordinary portland cement in concrete. But researchers have been testing other potential next-generation SCMs using materials ranging from ground glass and spent coffee grounds to rice husk ash and crushed seashells. Some new SCM ideas—such as ground recycled pottery and sugarcane waste—seem far-fetched. Yet others are well along in the R&D process.

The Commercialization Process

The commercialization process for new technology involves four important stages: bench/lab testing, pilot-scale trials, demonstration-scale project, and commercial-scale effort. Only those technologies that successfully progress from the bench/lab and pilot phases to demonstration- and commercial-scale acceptance have a chance of joining the list of next-generation SCMs. To succeed, a new SCM also needs significant volume—millions of tons per year—and to comply with a developed ASTM standard. To earn acceptance in the marketplace, it must be affordable and perform well in demanding infrastructure settings, stoking demand from builders, designers, and architects. Although alternative cements have long existed in the market, most have not gained market traction or broad acceptance due to commercialization failures, regulatory hurdles, and even insurance liabilities.

The Need for Decarbonizing Concrete

Concrete is the most widely consumed man-made material on earth. It's also a main driver of climate change. The concrete industry is responsible for about 8 percent of the world's carbon emissions—manufacturing 1 ton of cement manufacturing produces nearly 1 ton of CO2—and cement production is on track to exceed 6 billion metric tons by 2050. That's why a race is underway to discover a solution for decarbonizing the industry.

Concrete is comprised of cement, water, and aggregate—typically a mix of gravel and sand. The cement portion, most commonly ordinary portland cement (OPC), is the main culprit of concrete's carbon footprint. OPC is made from limestone, which releases significant amounts of CO2 embedded in the rock when heated. The energy required to heat limestone also produces carbon emissions. Since the use of limestone in clinker production can't be reduced, attempts to decarbonize the concrete industry often focus on using SCMs to replace a portion of the portland cement in concrete mixtures. For example, each ton of fly ash used to replace portland cement in concrete production saves nearly one ton of carbon dioxide from entering the earth's atmosphere.

This article looks at some of the "contenders" and "pretenders" in the race for the next generation of SCMs to decarbonize the concrete industry.

Photo from Vecteezy.com

Saint-Gobain Construction Chemicals

The Contenders ... Ground Glass

Ground-glass pozzolans (GGP) are a viable option for replacing a portion of the portland cement in concrete mixes. When ground to a powder, glass—which is comprised of sand, soda ash, and limestone—becomes a pozzolan that can improve concrete's wet and hardened properties. In addition to being an abundant waste material commonly recycled or disposed of in landfills, ground glass improves concrete by providing resistance to chloride penetration, sulfate attack, and freeze-thaw damage. In concrete, GGP has also shown improved resistance to alkali-silica reactivity (ASR) when reactive aggregates are present.[1] From a sustainability perspective, not only does ground glass displace carbon-intensive OPC, reducing the carbon footprint of concrete, but it also diverts waste materials from landfills.

GGPs have been in the marketplace for more than 10 years, and an ASTM standard for the material—ASTM C1866—was developed and published in 2020.[2] According to researchers, glass powder can replace up to 40 percent of portland cement.[3]

One interesting fact about glass as an SCM: color matters. When it comes to suppressing the alkali-silica reaction that causes concrete to crack and deteriorate, concrete containing green glass holds up better than clear, brown, or blue glass due to the presence of chromium.[4] Concrete containing glass powder as an SCM is about as strong as traditional concrete—and more durable.[5]

Urban Mining Industries, located in New York, is working to capitalize on the use of ground glass as an alternative SCM. The company's Pozzotive ground glass pozzolan product is a high-performing material that dramatically reduces embodied CO2 emissions in concrete. Pozzotive replaces up to 30 percent of portland cement in blended cement mixes and has been used in construction projects in New York and Connecticut, including the ESPN Digital Center 2, the New York Police Academy, and the Second Avenue subway station in Manhattan.[6]

Despite having many advantages, ground glass faces a major barrier to full commercialization: single-stream recycling.[7] To make their product, GGP manufacturers must first remove tons of other waste material—such as shredded paper and plastic bottle caps—comingled together with the glass. Separating glass from contaminants is difficult and expensive. If GGP is to succeed as an alternative SCM, new entrants will need to develop cost-effective methods to remove unwanted waste material at a rate of tons per hour. And the product will need to gain acceptance from end-users, namely builders, designers, and architects.

The Contenders ... Calcined Clay

Calcined clay, with its vast abundance in the Earth's crust and affordable production cost, is gaining ground as a next-generation SCM. When clay-rich soils are mined, ground, and heated (calcined) to between 650 degrees Celsius and 750 degrees Celsius, they become reactive, gaining pozzolanic properties that make them a suitable ingredient in concrete mixes. Calcined clays are available in large quantities, and their use as an SCM can improve the quality of cement and concrete.

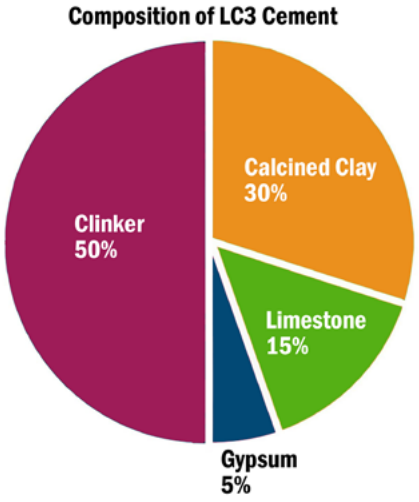
When used as a 20 percent replacement for standard portland cement, calcined clay can typically achieve a 15 percent reduction in embodied CO2 in concrete.[8] In 2023, however, Holcim announced it had launched Europe's first calcined clay cement operation in France to manufacture ECOPlanet green cement,[9] which delivers a minimum 30 percent reduction in cement-related emissions.[10]

Using calcined clay in blended cement mixes produces stronger concrete than when using ordinary portland cement alone. According to one study, a 15 percent replacement of OPC with calcined clay increased the compressive strength of concrete by more than 39 percent.[11] The study further found tensile strength and flexural strength of porous concrete also were improved, while porosity and permeability were reduced by more than 6 percent and 13 percent, respectively. Calcined clay also improves concrete's durability by improving its resistance to alkali-silica reaction, chloride penetration, and sulfate attack,[12] lengthening the service life of concrete.

Calcined clay technology has been around for decades and was used in the construction of the Pont Jacques Chaban-Delmas vertical lift bridge in Bordeaux, France. Its widespread adoption faces significant challenges, however, including difficulties in calcination, current lack of testing on major infrastructure projects, and few suppliers.[13]

The Contenders ... Limestone Calcined Clay Cement (LC3)

A close cousin of calcined clay is limestone calcined clay cement, or LC3. Originally conceptualized in 2005, this innovative cement results from a ternary blend of low-grade calcined clay with a further 15 percent of limestone as clinker substitution. It is considered a promising alternative to portland cement for its ability to reduce carbon emissions in the cement industry; the carbon intensity of limestone calcined clay cement is about 40 percent lower than that of OPC.[14]



The most common composition for LC3 is 50 percent ground portland clinker, 30 percent ground calcined clay, 15 percent ground limestone, and 5 percent ground gypsum—referred to as LC3-50.[15] LC3, which reduces clinker by about half, delivers the same mechanical performance as OPC.[16] Further, LC3 can be produced with existing manufacturing equipment, requiring only minimal increased investments. LC3 achieves lower emissions by reducing clinker content, decreasing fuel consumption, and using limestone without carbon-intense heating.

LC3 has significant appeal as an SCM. Not only are there abundant global supplies of raw clays and limestone, but LC3 is up to 25 percent cheaper in overall cost than ordinary portland cement—making it an attractive option for the global cement market.[17] However, researchers in India conducted an economic analysis of LC3 for the country's building and infrastructure needs and concluded LC3 is economically viable only where fly ash is more expensive, lower quality, and requires longer-distance transport.[18] Such conditions generally exist only in countries that do not have good sources of quality fly ash.

LC3 has proven itself a durable option for construction use. According to researchers in India, it demonstrates an increased resistance to chloride ingress and sulfate attack compared with traditional OPC. It also has lower alkali content, minimizing the risk of alkali-silica reactions and enhancing the longevity of concrete.[19]

The Bureau of Indian Standards recently issued an exclusive Indian Standard (IS) code IS 18189 for LC3.[20] In the United States, limestone calcined clay cement is covered in the ASTM Standard C595 and C595m for Blended Hydraulic Cement, and certain formulations are covered under ASTM C618.[21] Under the European cement standard EN-197-5, LC3-50 is allowed with up to 50 percent clinker replacement.[22]

Despite its rapid progress as a low-carbon solution for concrete, LC3's hurdles to broad marketplace acceptance include uneven availability of raw materials, lack of product awareness among construction professionals, and the need for promotion among builders and regulatory bodies.

The Contenders ... Rice Husk Ash

Rice husk is a waste byproduct from rice mills. When burned, it produces rice husk ash (RHA), which is rich in amorphous silica and has pozzolanic properties, making it a suitable ingredient in concrete. While husk is a coating that protects rice seed and grain during the growing season, rice husk ash is an agricultural waste that presents environmental problems in the soil and air. One solution to its negative impact is to process rice husk ash waste into a partial replacement for portland cement in concrete mixtures.

Globally, rice husk exists in abundant supply. The world produces more than 700 million tons of rice annually, which results in about 143 million tons of rice husks[23] and 7.4 million tons of rice husk ash.[24] When burned, 1 ton of rice paddy yields about 0.05 tons of rice husk ash.[25] Since the ash can be used as an SCM, rice husk ash can reduce the need to produce portland cement, lowering the carbon impact of concrete while at the same time solving the environmental challenge of rice husk ash disposal—mainly in countries where rice production is abundant.

Using rice husk ash as a partial cement replacement in concrete has been extensively researched. Studies have shown that, compared to ordinary portland cement, RHA improves concrete's strength, shrinkage, and durability. While rice husk ash has been tested in cement replacement amounts ranging from 5 percent to 50 percent by weight, researchers generally conclude RHA has the potential to replace cement by up to 10 percent to 20 percent without compromising concrete's workability, strength, and durability.[26] Use of RHA increases concrete's later-age compressive strength, abrasion resistance, and moisture barrier characteristics. Further, the ash significantly improves low drying shrinkage, a key indicator of durability in concrete.[27] The impervious microstructure of rice husk ash concrete provides better resistance to sulfate attack, chloride ingress, and carbonation. However, researchers note that workability significantly decreases with increasing amounts of RHA.

Rice husk ash has been successfully used in commercial manufacturing as a pozzolanic material in several countries, including Thailand, Colombia, and India,[28] and RHA production uses less energy, decreases the overall production cost of concrete, and emits fewer greenhouse gases than standard cement. It also leads to beneficial use of agricultural byproducts.

Like other SCMs, rice husk ash must meet ASTM C618-19 chemical composition standards in order to be used as pozzolan.

The Pretenders

Crushed Seashells - No chance

Recycled Pottery - No chance. Not enough volume to be meaningful.

Basil Ash - No chance. Not enough volume to be meaningful.

Carbon Black - No chance.

Spent Coffee Grounds - No chance. Not enough volume to be meaningful.

Sugarcane Waste - No chance. Not enough volume to be meaningful.

Nano-Calcined Excavation Soil - No chance. Not enough volume to be meaningful.

Rinsed Ilmenite Mud - No chance. Not enough volume to be meaningful.

Electric Arc Furnace Recycled Cement - No chance. Not enough volume to be meaningful.

Sorted Municipal Solid Waste Incinerator Ash - No chance. Not enough volume to be meaningful.

Biopolymers - No chance. Not enough volume to be meaningful.

However, the incineration, processing, and grinding of rice husk ash produce high loss on ignition.[29] So while well-burned and ground rice husk ash is highly suitable for cement mixtures, the sensitivity of combustion conditions in processing is viewed as a significant hurdle preventing its widespread use as a pozzolan.[30]

Photo: Southwest Concrete Pavement Association

The Contenders ... Calcium Silicate/Silicate Rock

Another material contending for next-generation SCM status is calcium silicate, or silicate rock. Unlike in conventional cement production, which involves heating carbon-intensive limestone, calcium silicate rock is carbon-free and may be capable of replacing 100 percent of the limestone in ordinary portland cement, potentially reducing the carbon emissions of concrete to zero.[31]

Calcium silicate, such as granite and basalt, is globally abundant in the Earth's crust, and cement products made from this material are hailed as ultra-low carbon, carbon-neutral, and even carbon-negative. Since calcium silicate can be mined virtually anywhere, these cement products can be made locally in large quantities, minimizing transportation costs while delivering a reliable supply. Early tests indicate that concrete made with calcium silicate rock exceeds existing specifications for strength, and its performance and composition are virtually identical to that made with ordinary portland cement.[32]

Manufacturers of silicate rock-based cements say the SCM offsets the use of portland cement in the 10-25 percent range for the most common concrete mix designs.[33] However, these firms envision products with 100 percent replacement of limestone that will achieve zero carbon emissions.[34]

Mining calcium silicate can be accomplished with already approved and open mines, and these new cement products have been approved for existing standards such as ACI 318 and ASTM C150. Manufacturers claim their calcium silicate-based cement will cost the same or less than conventional cement.

Oakland, Calif.-based Brimstone, which pioneered this technology, aims to open a pilot plant in 2025 and, if that is successful, a commercial plant in 2028.

Conclusion

With the climate change microscope now firmly fixed on cement and concrete, every week brings headlines touting "the new solution for decarbonizing the industry." While many of these technologies may hold promise, they first must address issues related to technical feasibility, scalability, and customer acceptance in infrastructure settings. The process can take years. For decades, the most commonly used SCM has been fly ash from coal power plants. Utilization of coal ash as a supplementary cementitious material—and iterative technology developments allowing ash utilization at high cement replacement rates—represents the low hanging fruit for achieving significant concrete decarbonization goals in the near term. Expanding use of this abundant resource in practices already accepted by the market is the key to achieving decarbonization goals faster.

***Bruce Parker** is Associate Editor of ASH at Work*

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EPD Technical Assistance for the Cementitious Materials Industry

By Eric Giannini, Ph.D., P.E.

Introduction

The Portland Cement Association (PCA) was one of 38 organizations selected to receive funding under the U.S. Environmental Protection Agency's grant program for Reducing Embodied Greenhouse Gas Emissions for Construction Materials and Products. The grant program was authorized by the Inflation Reduction Act of 2022, which allocated $250 million to the EPA for technical assistance to support the development of Environmental Product Declarations (EPDs) by U.S. manufacturers of construction materials and products. The American Coal Ash Association (ACAA), Natural Pozzolan Association (NPA), and Slag Cement Association (SCA) supported PCA's application and are collaborators on the grant.

PCA's five-year, $2.4 million grant aims to substantially increase the number of facility-specific EPDs for cements and supplementary cementitious materials (SCMs), including coal ash products, produced in the U.S. While approximately half of cement plants in the U.S. have developed EPDs for their products, very few SCM manufacturers have developed industry-average or facility-specific EPDs for their products. The project also supports efforts to create a single unified Product Category Rule (PCR) governing the development of EPDs for cement, slag cement, and other SCM products in North America, the development of industry-average EPDs for cementitious materials, and the development of a Life Cycle Assessment (LCA) Calculator and Benchmarking Tool that incorporates data from EPDs developed with assistance from this grant.

What are EPDs and PCRs?

EPDs are often likened to nutrition labels for foods, but instead describe the environmental impacts of a standard unit of a product. For example, the carbon footprint of a product may be reported as the Global Warming Potential (CO2-equivalent) per metric ton of that product, or GWP. EPDs provide transparency on environmental impacts, and the governing PCRs ensure that those impacts are determined and reported in a consistent and credible format. Internationally recognized standards such as ISO 14025 and ISO 21930 detail the core requirements for EPDs, including that they are subject to independent verification to ensure that impacts are reported in conformance to the governing PCR.

A notable difference from nutrition labels is that EPDs do not have an equivalent to the "percentage daily value." EPDs only report the impacts for a product—not whether those impacts are high, low, or somewhere in between in comparison to similar products. Industry-average EPDs can serve as a benchmark reference to aid in interpreting impacts for specific products, and subsequent revision to industry-average EPDs can be used to document industry progress over time toward reducing environmental impacts. For example, PCA's industry-average EPDs for portland cements published in 2016 and 2021 showed that the average carbon footprint decreased over 11 percent in that five-year period (see Figure 2).

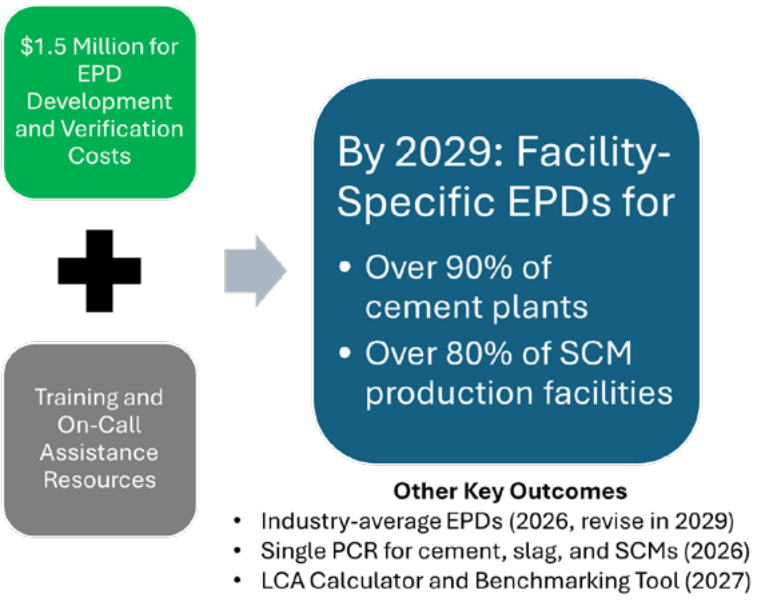

Figure 1. Overview of planned work in PCA's grant.

Figure 2. PCA's industry-average EPDs show progress in reducing the GWP of portland cement from 2016 to 2021, as well as the average reduction in GWP for portland-limestone cement compared to portland cement.

How Does This Impact the Coal Ash Industry?

PCA's grant will provide financial assistance in the form of reimbursements of EPD development and verification costs, up to $5,000 per facility, to U.S. producers of harvested and beneficiated coal ash products. A facility may reapply for additional reimbursement assistance to support revisions of EPDs (e.g., to demonstrate improvements resulting in reduced impacts) or to develop EPDs for new products being produced at that facility.

Consistent with EPA's goals for this program, producers that are developing EPDs for the first time, located in regions with few or no EPDs for a given product type, and qualified small and disadvantaged businesses will be prioritized in allocating these funds. This financial support will be leveraged with technical assistance in the form of training resources on EPD development and access to on-call assistance as coal ash producers work through the development and verification process. This will include training resources specifically tailored to the development of EPDs for coal ash products and guide coal ash producers every step of the way in this process.

PCA's grant will also fund the development, verification, and subsequent revision of industry-average EPDs for fresh and harvested coal ash products. Producers are strongly encouraged to participate in the data collection process, known as a life-cycle inventory (LCI) survey, whether they have completed their own development of facility-specific EPDs or not. Broad participation in the survey improves the quality and representativity of data in the industry-average EPDs, which serve as benchmarks for the entire industry.

Where sufficient data is available from the LCI survey, industry-average EPDs will be published with regional averages, in addition to national average values. Two rounds of LCI surveys will be conducted during the five-year period of the grant to permit documentation of progress and, given the likelihood that some harvesting operations will be completed while new ones come online during this time, ensure the revised EPDs are representative of facilities operating at the end of the project.

Advancing Sustainability in Concrete Construction

It is difficult to improve what you don't first measure—and impossible to prove that you've improved if you don't measure against where you started. Under this grant, the focus is on supporting facility-specific EPD development for beneficiated and harvested coal ash products, rather than fresh coal ash. Fresh, non-beneficiated ash is treated as a recovered material and minimally processed before it is used in concrete; the impacts associated with coal burning are not transferred to the ash product. Harvesting and beneficiation operations, however, are more energy intensive, so it is important to quantify the environmental impacts associated with those processes. These impacts are still quite favorable in comparison with an equivalent amount of portland cement that the coal ash replaces in a concrete mix, thereby reducing the carbon footprint of concrete. Harvested ash products, in particular, are poised to become an increasingly important part of concrete industry sustainability efforts.

PCA launched its Roadmap to Carbon Neutrality in 2021. It is now over three years later, and we are focused on walking that road, one step at a time, and demonstrating that we are making progress. By supporting not only first-time development of facility-specific and industry-average EPDs, but also revisions, PCA's grant from EPA will give the concrete industry verified data on the cementitious ingredients, which currently are responsible for the majority of concrete's environmental impacts, and gives the industry the tools it needs to demonstrate improvements over time.

Information on how to apply for assistance from the grant can be found at www.cement.org/EPAgrant, and questions to the project team can be directed to epagrant@cement.org. PCA intends to solicit applications for assistance quarterly through the end of the grant in 2029. A total of $1.5 million is allocated for direct reimbursement of facility-specific EPD development and verification costs to all sectors of the cementitious materials industry. Interested producers should also watch for announcements from PCA and ACAA of solicitations for assistance and webinars promoting the resources available from the grant program.

Figure 3. In October, PCA celebrated the third anniversary of the release of its Roadmap to Carbon Neutrality (www.cement.org/roadmap).

Summary

PCA and our collaborators at ACAA are excited to roll out a comprehensive assistance program for the U.S. cementitious materials industry, with funding from the EPA. We hope that ACAA members will make ample use of the resources provided through this grant and look forward to working and walking together on the path to carbon neutrality.

Eric Giannini *is the Director, Product Standards and Technology, for the Portland Cement Association. He is the project manager for PCA's grant from the EPA described in this article and can be reached at egiannini@cement.org.*

About the Portland Cement Association

The Portland Cement Association, founded in 1916, is the premier policy, research, education, and market intelligence organization serving America's cement manufacturers. PCA supports sustainability, innovation, and safety while fostering continuous improvement in cement manufacturing, distribution, infrastructure, and economic growth. For more information, visit www.cement.org.

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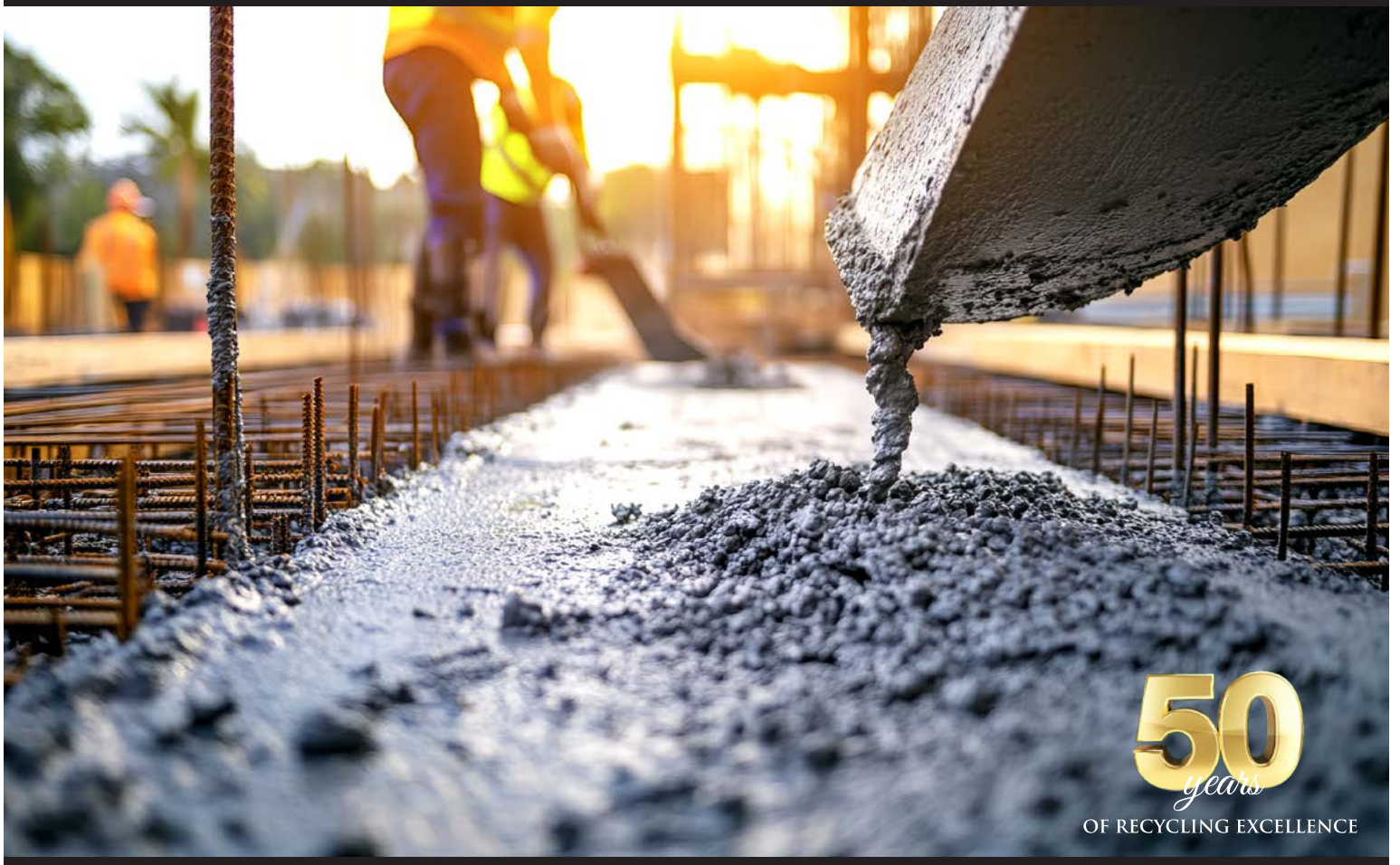

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Beneficial Use Case Study

Gross Reservoir Expansion Project

Coal Combustion Product Type
Fly ash

Project Name
Gross Reservoir Expansion Project

Project Location
Boulder County, Colorado

Project Participants
Denver Water, Eco Material Technologies, Kiewit Barnard (joint venture), Stantec, AECOM, and Black & Veatch

Project Completion Date
Summer 2027

Project Summary
Originally built in the 1950s, Gross Reservoir Dam is a 340-foot-high concrete structure that holds approximately 440 surface-area acres of water, supplying Boulder County and the city of Denver with robust water supplies and multiple recreational uses. After recognizing an imbalance in its overall water system, Denver Water, which owns and operates the reservoir, decided to raise the dam so as to enlarge the reservoir's capacity. Upon completion, the expansion project will make Gross Dam the tallest concrete dam in Colorado, nearly tripling the water storage capacity in the reservoir, from approximately 42,000 acre-feet to 119,000 acre-feet.

Project Description
Denver Water supplies water throughout Boulder County, Colorado. As part of its long-term planning goals, the utility determined that it needed a larger reservoir of water to prevent against drought and to address a vulnerability in its current system: 90 percent of the utility's water supply is stored to the south side of the city, while only 10 percent is stored to the north at Gross Reservoir.

The solution involved raising Gross Dam from its current height of 340 feet to 471 feet, which would make the structure the tallest concrete dam in Colorado. Denver Water began the preparation of the foundation in 2022 with the excavation of 260,000 cubic yards of rock and the placement of 27,000 cubic yards of concrete. In 2024, builders began raising the dam, with a goal of completing the project in 2027.

In keeping with its sustainability goals, Denver Water is using roughly 90,000 tons of Class F fly ash in its overall concrete production and placement. That fly ash, procured from Eco Material Technologies and sourced from the Prairie State Generating Station in Marissa, Illinois, will replace about 65 percent of the traditional cement used for producing concrete. The utility selected fly ash as a supplementary cementitious material because it makes the concrete mix more workable, meets the requirements to reduce heat of hydration, and reduces the effects of autogenous shrinkage. Not only does fly ash make finished concrete stronger and more durable, but it also reduces the need to manufacture as much cement, yielding significant greenhouse gas reductions.

The dam will be raised using 118 four-foot-high steps comprised of approximately 800,000 cubic yards of concrete. The concrete is produced on-site at a batch plant and transported to the dam site by conveyor, where it is added to the structure using a process called roller compaction.

Roller-compacted concrete (RCC) typically uses more fly ash and has lower water content than conventional concrete. It also has lower curing temperatures, lower embodied carbon, and is less susceptible to cracking. The partial substitution of fly ash for portland cement is important in RCC dam construction because the heat generated by fly ash hydration is significantly less than that of portland cement hydration, which reduces thermal loads on the dam.

Photo courtesy of Denver Water

Beneficial Use Case Study

Quay Quarter Tower

Coal Combustion Product Type
Fly ash

Project Name
Quay Quarter Tower

Project Location
Sydney, Australia

Project Participants
BG&E, Multiplex Construction, Boral Limited, De Martin & Gasparini

Project Completion Date
2021

Project Summary
Quay Quarter Tower, located in the Central Business District of Sydney, Australia, is an iconic skyscraper that offers some of the best views in the city. Built in 1976 at an original height of 623 feet, the building was deemed to have reached the end of its usable lifespan and, in 2018, underwent a three-year redevelopment that transformed the 46-story tower into a 709-foot, 54-floor high rise—all without demolishing the original structure. The tower is considered the world's tallest adaptive reuse project and serves as a model for how to reconstruct an existing building while saving natural resources.

Project Description
For Quay Quarter Tower's reconstruction, the project team set out to reuse as much of the existing building as possible. Instead of tearing it down and starting over, builders adopted an innovative rebuild technique that involved a top-down demolition of 30 percent of each floor and a simultaneous bottom-up construction of a composite steel-concrete jump-start structure.

To help cut carbon emissions during the reconstruction, structural engineers BG&E incorporated fly ash in wall, column, and slab concrete elements. The fly ash, supplied by Boral Limited and sourced from the Eraring Power Station and Mount Piper Power Station, replaced approximately 20 percent of the portland cement in the mix.

3XN QQT Photo (c)AdamMork 500 H

Engineers further combined ground granulated blast furnace slag with fly ash in the mix to achieve an overall 40 percent reduction in the requirement for portland cement. In addition to reducing the carbon footprint associated with the manufacture of portland cement, specifying "ternary" mixes for concrete elements can often produce a material with improved performance characteristics, such as higher compressive strength and reduced permeability.

Project developers ultimately retained over 65 percent of the structure's original beams, columns, and slabs, along with 95 percent of the original core. The new structure features concrete-filled tube columns, steel/concrete composite slabs, and 23,000 cubic meters of new concrete, while retaining the same amount of concrete from the original design. The reuse technique saved 12,000 tons of embodied carbon and set a global standard for extending the lifetime of tall concrete buildings. With a new service life projected to 2070, Quay Quarter Tower is considered a model of sustainable development.

The results have drawn international acclaim. In 2023 Quay Quarter Tower received multiple awards, including "Best Tall Building Worldwide" by the Council on Tall Buildings and Urban Habitat. It also earned the award for overall excellence at the American Concrete Institute's 2023 convention and received the Kevin Cavanagh Medal from the Concrete Institute of Australia. Today, Quay Quarter Tower is recognized as the world's tallest upcycled skyscraper.

The Use and Standardization of Rapid Test Methods for Measuring the Carbon Content and Fineness of Fly Ash Pozzolan

By R. Doug Hooton and J.H. Phil Buckingham

This paper was presented, and is in the proceedings of the 7th International Ash Symposium, in 1985 by Doug Hooton, then with Ontario Hydro.

While highly variable, high-carbon ashes are less common today, the rapid test methods employed still have relevance 39 years later, as they are now more widely used. The air-jet sieving method is a rapid alternative to the ASTM wet sieving method; has an ASTM standard, C1891, Standard Test Method for Fineness of Hydraulic Cement by Air Jet Sieving at 45-µm (No. 325); and although not cited in C311, it is referenced in ASTM C595/C595M, Standard Specification for Blended Hydraulic Cements. The LECO carbon analyzer is a rapid alternative to the C311 Loss on Ignition test method and is referenced in C114 as a Combustion Gravimetric Method.

In this particular application, these methods were used from 1975 until the power plant closed to provide data on the delivery ticket of every truckload of ash from a peak-load power plant. This allowed concrete producers to successfully utilize this variable ash, as they were provided with calibration curves that allowed adjusting their mix proportions both for water demand and air requirements.

—Doug Hooton

Abstract

Loss on ignition and fineness are two of the most important fly ash properties for the concrete producer to know in order to adjust his mix proportions and admixture doses. However, these standard test values are not usually available in time to allow adjustments to the concrete mix proportions.

At Ontario Hydro, a LECO carbon analyzer and an Alpine air-jet siever have been employed as rapid test alternatives. Results are given to the truck driver only a few minutes after the tanker is filled. These rapid methods to supply carbon and fineness measurements to customers with every truckload of fly ash pozzolan sold have been in place at the Lakeview generating station since 1975.

Relationships between the current standard and rapid test values are given together with recommendations for adoption of these rapid tests as alternative methods to the standards.

Introduction

Ontario Hydro has a history of using its bituminous coal-fired thermal power plants for peak-load electricity demands due to the availability of nuclear and hydraulic base-load generation capacity. Because of this, the carbon content and to a lesser degree the fineness of the fly ash byproduct can be quite variable. In spite of this, Ontario Hydro has utilized fly ash in its own concrete construction projects since 1950 (Sturrup, Hooton, and Clendenning, 1983), conducted extensive research on effects of fly ash on concrete (Clendenning and Durie, 1962; Clendenning and Loughborough, 1976; Mustard and MacInnis, 1959; Sturrup and Clendenning, 1969), and since the 1970s it has also been marketed externally. On internal projects alone, more than 1,500,000 m^3 of fly ash concrete has been utilized, mainly for control of heat of hydration and alkali-reactive aggregates, while externally over 4,000,000 m^3 of fly ash concrete is evidenced in Southern Ontario mainly for economy and high-strength reasons. Due to carbon contents generally exceeding 6 percent, this ash is not actively marketed for air-entrained concrete, although it has been used successfully in air-entrained concrete where close control on variability was maintained.

Standard Tests

Both ASTM C618 and Canadian Standards Association (CSA) A23.5 limit the loss on ignition (LOI) of fly ash pozzolans to control their maximum carbon contents. Excessive carbon in ash can cause undesirable variations in color for architectural concrete and can reduce the effectiveness of air-entraining agents (AEA) for freeze/thaw-resistant concretes (however, provided that adequate air contents are attained through higher doses of AEA, freeze-thaw resistance can be attained with fly ash carbon contents in excess of 12 percent [Sturrup, Hooton, and Clendenning, 1983]). Since carbon does not contribute to pozzolanic reactions, it also can reduce the reactivity of fly ash by dilution. However, high-carbon ashes also tend to have higher surface areas, which help reduce the dilution effect (Clendenning and Durie, 1962).

The fineness of fly ash, measured in ASTM C311 by wet sieving on a #325 (45µm) sieve, is important since like all cementing materials, reactivity is a function of fineness.

Together, these two properties are the most important for the concrete producer to know, which is why the multiple factor (% LOI multiplied by the % retained on the #325 sieve) is also limited in C618 (optional).

The Need for Rapid Tests

If the concrete producer knows the LOI and fineness of the ash as each tanker is delivered to his plant, his mix design can be adjusted accordingly to avoid problems in the hardened concrete. If the ash is coarse, the cement content may have to be adjusted upwards or more ash added to compensate for lower strength development. If the LOI is higher than normal, the AEA dose can be increased, using calibration curves (like the one developed by Clendenning and Durie, 1962) to maintain the constant air contents.

If the color of the concrete is important for architectural purposes, the fly ash replacement of cement can be reduced so that the total carbon content of the concrete is kept constant.

If the fly ash supplier can determine the LOI and fineness of each shipment of ash before it leaves the power plant, he can ensure that the ash will meet the ASTM C618 requirements and can re-direct non-specification fly ash to disposal or uses other than in concrete.

A major drawback to the standard ASTM LOI and fineness tests in C311 is the length of time required before results are obtained.

As well, knowing that the LOI and fineness of each shipment of fly ash meets specification also helps protect the supplier from legal action in case problems occur in the concrete. Often, when low concrete strengths are obtained, the quality of the fly ash is immediately suspect. However, experience has shown that low-strength fly ash concrete problems are often traced to the concrete batch plant when either the weigh scales have malfunctioned or, in one case, the division plate between the fly ash and cement silos had split.

A major drawback to the standard ASTM LOI and fineness tests in C311 is the length of time required before results are obtained (usually several hours). When a typical 30-ton tank truck is loaded at the power plant or storage silo, an ash sample is taken from the top hatch and tested. However, the truck cannot be delayed until the standard tests are obtained. By that time, the fly ash is often already blown into the concrete producer's silo and some may be in concrete. This is too late to ensure that the ash meets ASTM requirements or to make adjustments to concrete mix proportions.

Therefore, in 1975, Ontario Hydro adopted the use of rapid test methods at its Lakeview fly ash processing plant, and since then each tank truck driver has been provided with the carbon content and fineness values printed on his waybill before leaving to deliver the load. Using the rapid methods, the truck is only delayed for between 5 and 10 minutes.

These rapid methods and the relationship between the rapid results and the ASTM C311 standard methods are discussed in the following sections.

LECO carbon analyzers are a rapid alternative to the C311 Loss on Ignition test method. (Photo: LECO Corporation)

The Automatic Carbon Analyzer

LECO carbon analyzers can be found in most analytical laboratories requiring carbon analysis and have the advantage with fly ash of only measuring carbon content, which is the subject of interest in the C311 test (LOI is only an indirect way of estimating carbon content).

The fly ash sample is placed in a disposable crucible and burned for one minute in an induction furnace along with copper and iron chip accelerators. The sample chamber of the furnace is sealed, and during the burning the combustion products are carried in an oxygen stream to the measurement unit, cooled, and the carbon, now converted to CO_2 gas, is collected in a molecular sieve trap that holds the CO_2 as long as it is below 60°C. The molecular sieve is then heated to 300°C to release the CO_2 into a gas stream, which carries it to the conductivity cell where the carbon content is measured and output onto a digital display.

While it may at first sound complicated, the equipment simply consists of the furnace unit, where the new sample is placed and the old one removed, and the measurement unit (Model WR-12), where the result is displayed. The entire operation takes only 2 to 3 minutes and since it is fairly well automated, it can be operated by existing staff with minimal training required. Each morning when the equipment is turned on, the calibration can be adjusted using standard materials. The sample size is 1.000 g for ashes with expected carbon content less than 5 percent, 0.500 g for less than 10 percent, and 0.250 g for less than 20 percent. The results are most accurate for the largest sample size that can be accommodated for the range of carbon contents expected. The expected carbon content range usually known from previous LOI data can also be estimated by the fly ash color or can be quickly established by initially running on the 0 to 20 percent range. Required accessories include an accurate weigh balance, an oxygen tank and regulator, as well as the accelerators, calibration standards, and crucibles.

Rapid Air-Jet Siever

An Alpine (Model 200) vacuum-operated air-jet sieve is used with a 10.00 g sample. This equipment has a rugged cast-aluminum housing that holds a 20-cm-diameter (approximately 8 inches) stainless steel #325 (45µm) sieve and a transparent sieve cover. A split nozzle rotates slowly below the sieve and a current of air, produced by the vacuum of a standard vacuum-cleaner-type device, blows upwards through a slit nozzle under the sieve and blows the screen free. The particles suspended in air (between the sieve cover and the sieve) are separated as the air current circulates. The fine materials are sucked through the screen and into a filter bag. The coarser materials remain on the top of the sieve. A manometer indicates the vacuum on the underside of the sieve housing to ensure that proper operating vacuum is attained.

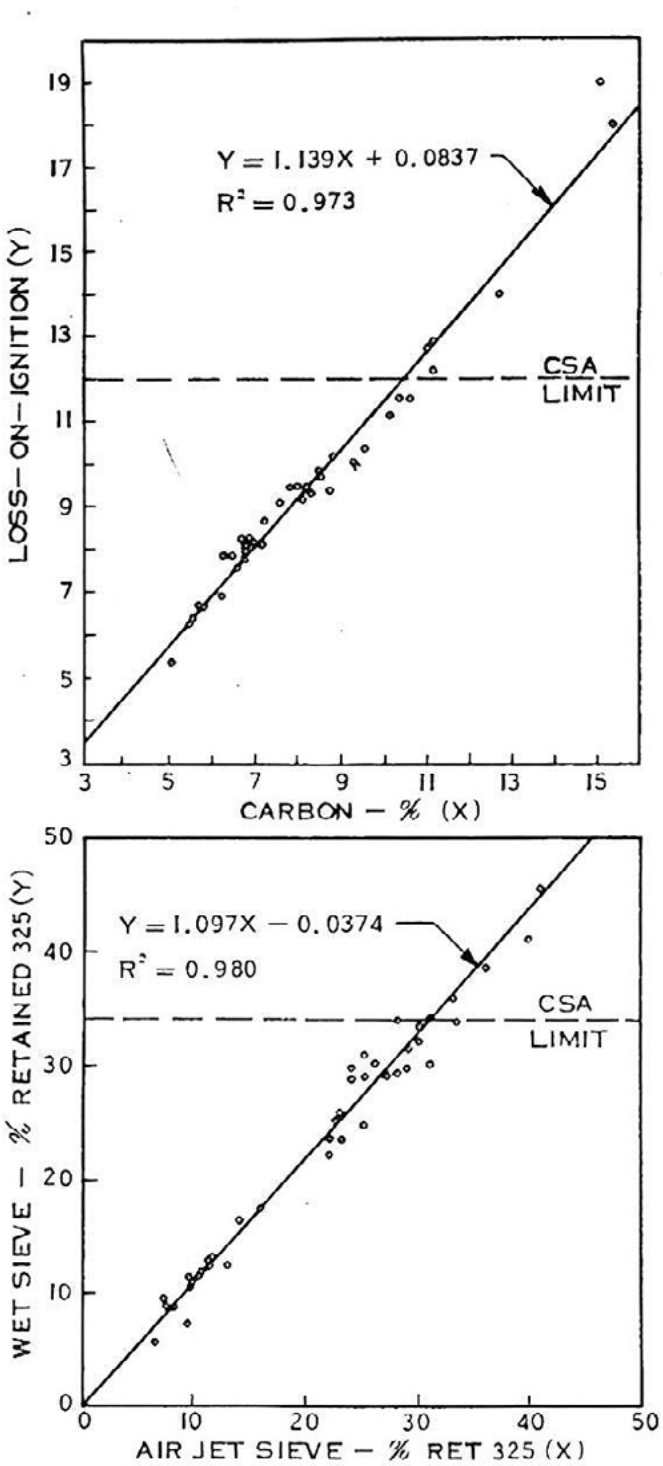
To determine the percent retained, the sample is weighed and placed on the #325 (45µm) sieve and covered. The air-jet sieve is operated for two minutes and then the residue remaining on the sieve is re-weighed. The percentage retained is obtained by weight comparison.

Air-jet sieving methods are an alternative to the ASTM wet sieving method. (Photo: Hosokawa Micron Ltd)

While rapid methods of determining the carbon content and fineness of fly ash are not meant to replace standard testing for quality assurance, they allow both the producer and users of fly ash to have an indication of these properties before and after it is shipped and before it is used in concrete.

Results

When these test procedures were first adopted, relationships of the results to those obtained by the standard ASTM procedures were established. Using over 40 sets of results (LOI ranged from 5 percent to 9 percent, percentage retained from 5 percent to 45 percent), linear relationships were observed between LOI and carbon contents and also between wet sieve and air-jet sieve values as shown in the figure below. The regression analysis gave the following equations (see facing page):



ASTM LOI (%) = 1.139 (% carbon) +0.08

(Correlation coefficient, $R^2 = 0.973$)

ASTM Wet Sieve (% retained) = 1.097 (% retained on air-jet sieve) – 0.04

(Correlation coefficient, $R^2 = 0.980$)

The scatter of the results is small for both equations and the fits are excellent as indicated by the strong regression correlation coefficients.

To avoid confusion with standard ASTM test values, the results printed on the truck waybills are the actual carbon and air-jet sieve results. The empirical equations relating to standard test values may change with coal source and boiler conditions. For example, more recent results on ash from low-sulfur coals gave a slightly different equation for the LOI-carbon relationship. Using the original equation, the estimated LOI values appear to be low by approximately 0.25 percent. This would not be unexpected, since with different coal compositions and firing compositions, the ratio of volatile and oxidizing components to carbon contents would result (LOI measures carbon, other volatiles, and weight changes due to oxidation reactions).

Adoption of Rapid Methods in Standards

Two routes can be taken in trying to have these rapid methods included in standards such as ASTM:

- Developing separate detailed specifications for the use and calibration of these rapid test techniques; or
- Adding short paragraphs to the existing C311 procedures allowing use of any rapid techniques as long as the results meet specified precision and accuracy criteria.

The second alternative would appear to be the more desirable, since it would not limit rapid methods to those described in this paper, and the present ASTM methods could be used in cases of dispute (ASTM C114 presently includes such allowances for rapid methods of chemical analysis of cements).

While the carbon analyzer can be calibrated daily or most often using standard materials, standard materials should also be used to calibrate the air-jet sieve at regular intervals, similar to the method given in ASTM C430 after perhaps every one hundred tests (this number still needs to be established). As well, our present system is to use three sieves in rotation. If one of the three sieves is damaged, the difference between consecutive results should draw immediate attention to the problem.

Work is presently underway to try and develop specific calibration techniques for standardization of these methods.

Conclusions

Rapid methods of determining the carbon content and fineness of fly ash have excellent correlations to standard ASTM loss-on-ignition and wet-sieving techniques. While these methods are not meant to replace standard testing for quality assurance, the rapid methods allow both the producer and users of fly ash to have an indication of these properties before and after it is shipped and before it is used in concrete. Thus, the producer has better assurance that the ash meets specifications, and the user can adjust his mix proportions to take maximum advantage of the ash while producing quality concrete. The proposed rapid methods are not complex and their operation can be learned by existing staff. While general suggestions for including these methods in standards are given, specific details are still being worked out.

Certainly the existing established methods of knowing after the event are not in keeping with modern technology and the sophistication being given by architects and civil engineers to materials used in large projects and high-rise concrete structures. Adoption of rapid tests such as those described in this paper is therefore fully justified.

At the time of the original publication of this article, ***Doug Hooton*** *worked as Concrete Materials Engineer in the Civil Research Department at Ontario Hydro. He is now the NSERC/CAC Industrial Research Chair in Concrete Durability and Sustainability at the University of Toronto, where his research involves finding ways to reduce the greenhouse gas emissions associated with concrete infrastructure.*

At the time of the original publication of this article, ***J.H. Phil Buckingham*** *worked as Supervisor, Ash Marketing, at Ontario Hydro, where he worked until his retirement.*

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I'm Glad You Asked

Editor's Note: "I'm Glad You Asked" is a recurring feature that invites a different expert each issue to answer a commonly asked question about coal combustion products. If you would like to submit a question and/or volunteer to provide a written answer to one, please contact the editor at johnfsimpson@gmail.com.

This issue's guest columnist is Alison Premo Black. Alison is the Senior Vice President and Chief Economist at the American Road and Transportation Builders Association. She is responsible for over 140 studies examining national and state transportation funding and investment patterns, including the association's tracking of federal infrastructure investment. She has authored several reports for the American Coal Ash Association on the use of coal combustion products in the transportation construction market and the outlook for the U.S. fly ash market. She received her Ph.D. in Economics from The George Washington University and is frequently interviewed as an industry expert.

Q. With the landmark Infrastructure Investment and Jobs Act crossing the midway point, how is this impacting the highway and bridge construction market and the demand for coal combustion products?

A. Federal investment through the Infrastructure Investment and Jobs Act (IIJA) has helped support record levels of highway and bridge construction despite supply chain issues, rising material prices, and labor costs. As the five-year IIJA program, enacted in November 2021, crosses the halfway point, there is strong evidence of real market growth.

The increased market activity will help drive greater demand for the beneficial use of fly ash and other coal combustion products that are used in applications such as concrete, blended cement, and structural fills. Some of our previous research for the American Coal Ash Association estimated that fly ash is utilized in more than 75 percent of the concrete used in highway and bridge construction, especially in states such as California, Florida, Louisiana, New Mexico, Nevada, Utah, and Texas.[1]

Over the last 30 months, IIJA investment has helped support significant increases in major indicators, including contract awards, highway and bridge contractor employment, and construction activity. ARTBA analysis suggests that there is still a lot of IIJA funding on the horizon.

States have committed over $130 billion of funds available under the IIJA, with over $70 billion being reimbursed to states for work completed, accounting for just 20 percent of the total funding over the five-year period. Many projects supported by discretionary grants and the new formula bridge program have yet to enter the construction phase.

IIJA Flow of Funds

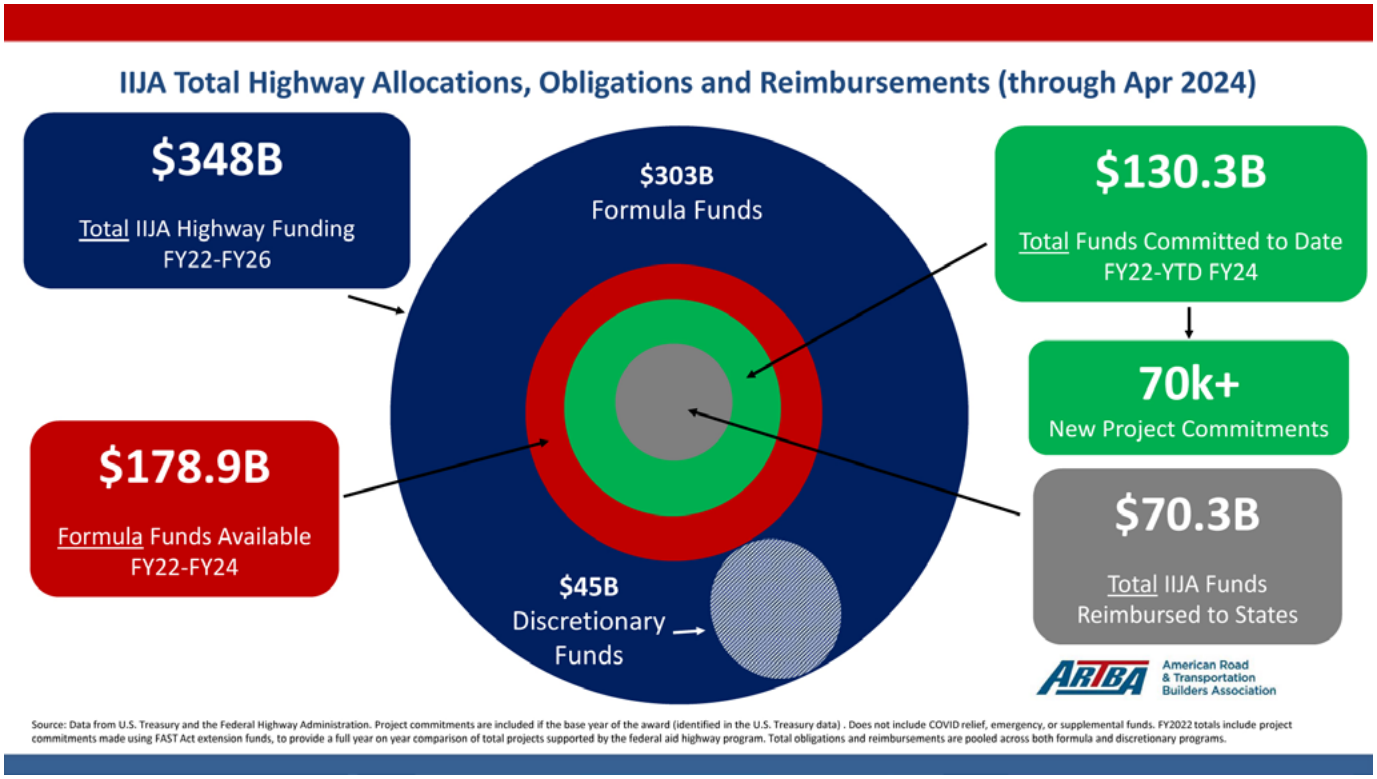
IIJA provides nearly $350 billion in federal highway and bridge funding over five years (FY 2022-2026), split between formula funds ($303 billion) and U.S. DOT-controlled grants ($45 billion). The largest step-up occurred in the first year (FY 2022), with total funding levels rising about 40 percent.

New under IIJA is a bridge formula program, which accounts for an additional $5.5 billion (26 percent) of the average annual funding increase, and an electric vehicle (EV) formula program, which adds $1 billion (5 percent) per year. Congress granted the states four years to obligate funding from these programs. Halfway through IIJA, however, only about $7 of $16 billion (43 percent) in available bridge formula funds and $200 million of $3 billion (7 percent) in available EV formula funds have been obligated, meaning there is more work to come in these areas.

IIJA Market Impacts

There is an obvious connection between the historic increase in federal funding under IIJA and atypical growth in major market indicators, many to record levels:

- **New Federal-Aid Highway Formula Fund Projects:** There have been more than 70,000 new formula project commitments under IIJA.
- **State and Local Government Contract Awards:** Both the value (+27 percent) and number (+14 percent) of highway and bridge contract awards experienced record growth in 2022. In 2023, the value and number rose an additional 9 percent and 4 percent, respectively. For perspective, typical growth rates are about 4 percent and 1 percent.



- **Employment:** On a seasonally adjusted basis, the highway, street, and bridge construction industry added nearly 40,000 jobs (+11 percent) over the first half of IIJA. Industry employment surpassed record levels in 2023 and has continued rising since on a year-over-year basis.

- **Construction Activity:** Given the multi-year project pipeline, the value of construction activity lags leading indicators. Whereas typical growth in construction for highways and bridges averages 4 percent per year, market activity was up 10 percent in 2022 and a record 18 percent in 2023. While growth in contract awards has moderated in 2024, now to a significantly higher baseline, construction activity has continued to increase at a 15 percent year-to-date rate. The spend-out of IIJA funds, and related construction activity, is expected to continue rising through the life of IIJA.

Fifty State Markets

Underlying the national totals are 50 different state markets with variations in federal funding priorities, state revenue health, and procurement practices. For example, nearly 80 percent of IIJA-supported project value in Texas is geared toward construction, whereas this share is less than 45 percent in Oregon, which has prioritized more planning and design work.

As a result, demand for CCP materials may differ significantly, even controlling for different program sizes. ARTBA's public highway dashboard, market intelligence service, and custom economics work are designed to help the industry analyze this state-level variation. Detailed information on the projects supported by the IIJA is available at www.artba.org.

Midway through the IIJA, the market has achieved new records, despite macroeconomic challenges. While every state is different, IIJA-supported projects have been initiated in nearly every county of the United States. And nearly 80 percent of total IIJA funding remains to be spent.

Endnotes

1. Black, Alison. 2011. *The Economic Impacts of Prohibiting Coal Fly Ash Use in Transportation Infrastructure Construction*. Available at https://acaa-usa.org/wp-content/uploads/2021/05/2011FlyAshStudy_lowres-FINAL.pdf.

Reduce the Risk of Household Chemical Emergencies

Editor's Note: As a service to our readers, ASH at Work publishes a recurring series on everyday health and safety topics. We welcome contributions from readers with expertise in health-related issues. Article length should be approximately 500 words. Please submit topic suggestions in advance to John Simpson at johnfsimpson@gmail.com.

Photo by Wanlop/Adobe Stock Image

Virtually every household uses products that contain hazardous chemicals. Knowing how to store and handle these materials can reduce your risk of injury or accidental death.

Before a Household Chemical Emergency

- Identify which materials are potentially hazardous, e.g., cleaning products, furniture polishes, pesticides, auto products, batteries, flammable products, painting supplies, herbicides, and pesticides.
- Store household chemicals in places children can't access, and lock or childproof cabinets and storage areas if you have children in your home.
- Keep products containing hazardous materials in their original containers and don't remove the labels unless the container is corroding; corroding containers should be repackaged and clearly labeled.
- Don't store hazardous products in food containers.
- Never mix household hazardous chemicals or waste with other products, as some chemicals, such as chlorine bleach and ammonia, may react, ignite, or explode.
- Read and follow the directions when using a new product to avoid inhalation or contact with potentially hazardous chemicals.
- If you don't already have one, buy a fire extinguisher that is labeled for A, B, and C class fires and keep it handy.

During a Household Chemical Emergency

- Clean up chemical spills immediately with rags, being careful to protect your eyes and skin.
- Recognize and respond to symptoms of toxic poisoning: difficulty breathing; irritation of the eyes, skin, throat, or respiratory tract; changes in skin color; headache or blurred vision; dizziness, clumsiness, or lack of coordination; and cramps or diarrhea.
- Do not give anything by mouth unless advised to do so by a medical professional.
- If a person is suspected to have breathed, swallowed, or otherwise come into contact with a hazardous chemical, contact the Poison Control Center at 800-222-1222.
- If a hazardous material causes a fire or explosion, evacuate your house immediately, stay upwind, and call 911.

After a Household Chemical Emergency

- Discard clothing that may have been contaminated.
- Allow any rags used to clean a chemical spill to evaporate outdoors in a safe place, then wrap them in a newspaper, place in a sealed plastic bag, and dispose of the materials with your trash.

Materials adapted from Ready.gov and the American Red Cross.

- *Wet Ash Pond Closure Partnerships*
- *Amphibious CCR Excavation*
- *Landfill Construction, Operation & Closure*
- *Water Management and Dewatering*
- *Value Engineering*
- *Mass Earthwork & Conventional Heavy-Civil*
- *In-situ CCR Testing*
- *Soil and CCR Chemical Stabilization*

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WOCA 2024 Smashes Attendance Records

The 2024 World of Coal Ash reached new heights May 13-16, 2024, at the magnificent Amway Grand Plaza hotel in Grand Rapids, Michigan. The 1,260 participants who descended upon the city for the event topped all previous attendance records, beating out the final tally of 1,057 attendees who participated in WOCA 2022. The week's activities included over 230 presentations and two informative keynote speeches, while the exhibit hall was sold out with 125 exhibitors from around the world.

In the opening keynote address, Eco Material Technologies CEO Grant Quasha shared his vision for the future of coal ash and decarbonizing the built environment. In the second keynote address, Portland Cement Association Senior Vice President and Economist Edward Sullivan provided an in-depth look at economic trends that will affect the concrete construction market.

Presentations and proceedings papers from WOCA are now available online for viewing at https://uknowledge.uky.edu/woca/woca2024. The info-packed conference was complemented by evening social gatherings, including a fun-filled trivia night featuring dinner, beer-tasting, prizes, and live music at the 170-year-old Grand Rapids Public Museum.

The American Coal Ash Association and the University of Kentucky Center for Applied Energy Research would like to thank the sponsors, exhibitors, and attendees who helped make WOCA 2024 the biggest and best yet!

WOCA 2024 Award Recipients

WOCA Student Poster Award
Sponsored by American Coal Ash Association Educational Foundation

Winner: Krish Mehta, Stanford University

WOCA Student Oral Presentation Award
Sponsored by Midwest Coal Ash Association

Winner: Agnes Dube, The United Graduate School of Agricultural Sciences

WOCA 2024 Poster Award (non-student)
Sponsored by Electric Power Research Institute

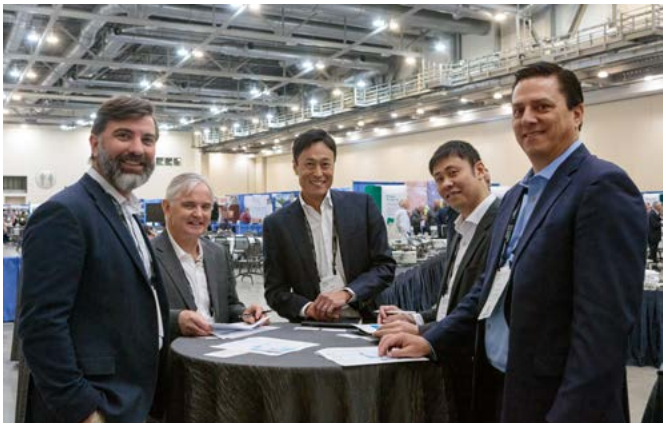
Winner: Dr. Ann Ojeda, Auburn University

Alice Marksberry Memorial Award for Best Oral Presentation
Sponsored by University of Kentucky Center for Applied Energy Research

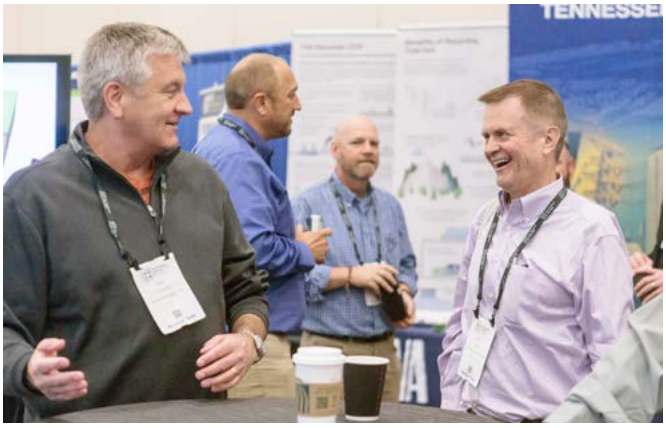
Winner: Dr. Lisa Burris, The Ohio State University


WELCOME TO
WCA
2024

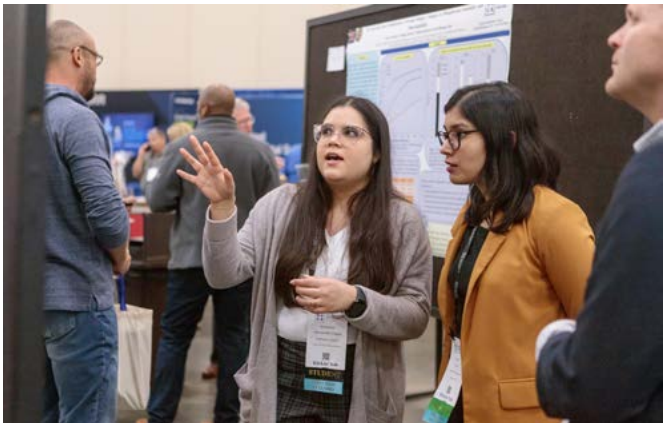

Attendees

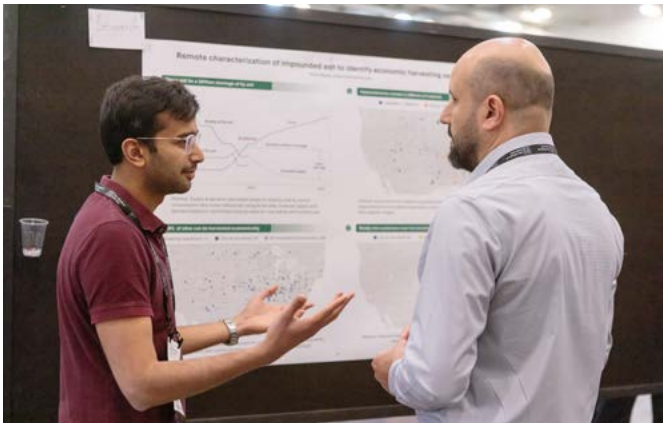



The World of Coal Ash 2024
1st FLOOR
EXHIBIT HALL C
Registration, Breakfasts, Lunches, Poster Session, Welcome Reception, etc. (see Program)
BALLROOMS B,C,D
Opening Session & Plenary
SESSION ROOMS
Ramme, Kruger, Manz, Cain, McKinley, Caylor
2nd FLOOR
SESSION ROOMS
Marksberry, Goss, Robl, Adams
AMWAY GRAND PLAZA
ATRIUM ROOM
Student Lunch




EP Power Minerals



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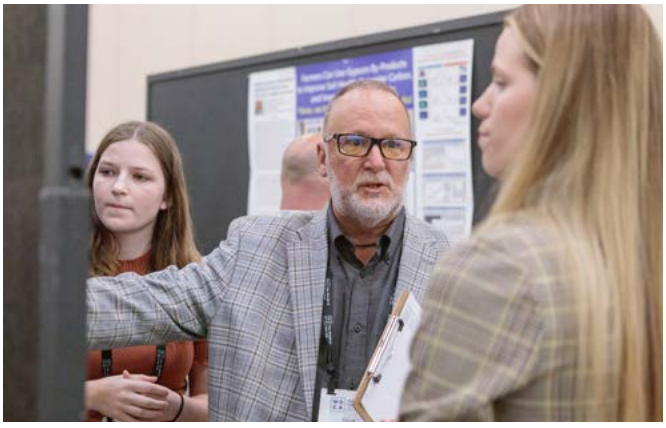
THE PLASTICS EXPERTS.



6 Questions for Mark Rokoff

Editor's Note: "6 Questions for..." is a regular ASH at Work feature in which leaders with unique insight affecting the coal ash beneficial use industry are asked to answer six questions.

Mark Rokoff is a business development director and coal combustion residuals (CCR) specialist at Burns & McDonnell. With more than two decades of experience, Mark has worked with some of the nation's largest power utilities to deliver safe, cost-effective solutions to complex environmental challenges. His experience includes regulatory compliance, innovative site and design solutions, and water management, particularly within the evolving coal combustion products (CCP) sector.

While the story of coal ash and Mark Rokoff may not begin with a dramatic event, a childhood obsession with CCR, or a magical moment involving a fairy godmother, his career is no less legendary than a tale told around campfires. Mark's fascination and passion for the subject are evident in every conversation. He graduated from Case Western Reserve University over 25 years ago with a master's degree in civil-geotechnical engineering and a desire to solve complex challenges. He immediately began working on coal ash projects, understanding the complexity of puzzle-solving in a material that was still being understood.

For the last 15 years, Mark's focus has largely been on developing technical solutions and strategies for effective CCR management and compliance within an ever-changing regulatory framework. In his current role as Principal, Business Development Director for the Environmental Services Group with Burns & McDonnell, Mark is grateful for his career adventures and continued opportunities to solve technical problems in collaboration with coworkers, clients, and friends.

ASH at Work (AW): What is the EPA "Legacy" Coal Combustion Residuals (CCR) rule and how does it apply?

Mark Rokoff (MR): A brief disclaimer: To truly understand how the rule applies to a particular site and potential site-specific necessary actions, one should consult the legacy rule directly (40 CFR 257 *"Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Legacy CCR Surface Impoundments,"* May 8, 2024).

To set the stage, I won't be delivering good news, but rather presenting news well. There's a lot to cover, and I'll do my best to highlight the key points.

Following the release of the 2015 CCR rule, litigation ensued, and after a nearly three-year battle, the D.C. Courts responded in August 2018. Among other topics, the U.S. Environmental Protection Agency (EPA) was directed to establish rules to regulate what would become legacy surface impoundments (LSIs) at inactive power plants. An LSI is defined as a CCR surface impoundment that no longer receives CCR but contained CCR and liquids on or after October 19, 2015. During the development of these rules, EPA introduced a new term identifying CCR Management Units (CCRMU), or any area of land where CCR is received, placed, or otherwise managed after the effective date (November 8, 2024) that is not containerized nor in a unit that is already regulated. The legacy rule is a self-reporting rule requiring the owner/operator (O/O) to determine the appropriate interpretations to implement the rule requirements, many of which are to be posted on a publicly available website.

To consider how the legacy rule applies to a given site, first determine whether the facility is active or inactive. If the site or plant generated power after October 19, 2015 (the effective date of the 2015 CCR rule), then the site is active. If not, then the site is inactive. Note, if there is active generation (non-coal) within the facility boundary at any time after October 19, 2015 (e.g., new gas generation, a new solar farm providing power to the grid, a wind farm that has come online, etc.), the site meets the definition of an active facility. Additionally, if there is an active offsite disposal unit located beyond the facility boundary of the generating station, meaning that it is a regulated CCR unit, this active offsite disposal unit would be considered an active facility as well.

Armed with the knowledge of the facility operational status, the next step is to determine the presence or absence of a CCRMU within the facility boundary for the owner/operator (O/O) to document formally in a Facility Evaluation Report (FER). An FER is required for all active facilities; however, for an inactive facility that is also home to an LSI, the O/O is required to complete an applicability report for all LSIs and conduct an FER. However, if the inactive facility does not have an LSI (for example, it may only have a former landfill onsite), then no further action is necessary.

AW: What is an FER and how should an owner/operator approach this?

MR: Great question. Consider the Facility Evaluation Report Part 1 and 2 to be the formal documentation following a two-part site evaluation reporting the findings of the effort

to assess the presence or absence of CCR and the vertical and horizontal extents (as well as other required information) within the facility boundary. The first part is a "desktop" evaluation of "reasonably and readily available records" from the plant seeking to find the presence (or absence) of CCR. The final sub-part of Part 1 is to document the gaps in the data and the approach to resolve them through investigations.

And before you ask, if the data does not exist (e.g., a subsurface investigation or historic design), the O/O is not required to "create" the information. The rule states that information is to be considered if it is "reasonably and readily available."

The second part is the investigation phase to address the Part 1 data gaps identified. While the method and extent of the investigations may vary, the intent is still to identify and delineate possible CCRMUs. The culmination of the effort is the second part of the FER documentation (also posted to the website). Remember, this is not a treasure hunt! The evaluation is intended to resolve data gaps and is not meant to "hunt" through the site for possible buried CCR.

AW: What are the key deadlines that owners of these sites need to meet?

MR: Having been published nearly six months earlier (May 8, 2024), the effective date of the rule is November 8, 2024. There are several items due on this date, such as the LSI applicability report, site security, inspection monitoring, website, etc., but all for an LSI. The possible CCRMUs will not be "fully defined" until the submittal of the FER Part 1 on February 9, 2026, and FER Part 2, which is due one year later (February 8, 2027).

And I know what you are thinking (hoping) … when one submits these reports, the O/O is done?!? Submitting these reports does not mean the O/O is done. Several compliance and engineering documents are required for LSIs (e.g., history of construction, safety factor demonstration, run-on/run-off evaluation, etc.) that are not necessary for CCRMUs. However, for both an LSI and a CCRMU (those with more than 1,000 tons), groundwater monitoring, corrective action (as needed), and closure are required.

While tasks for an LSI are generally due one year before a CCRMU, some dates require a greater effort to meet the deadlines than is simply conveyed. For example, the legacy rule requires groundwater monitoring, statistical evaluation, and reporting to be initiated on May 8, 2028. While this may feel like a fair amount of time, to comply with this date all this work must begin years prior (shortly after the FER Part 1 is submitted). This is especially true when undertaking more robust groundwater due diligence associated with data analysis techniques like environmental sequence stratigraphy (ESS) to inform a comprehensive conceptual site model (CSM).

There are many key dates presented in the legacy rule preamble within Tables 1 and 2 that are worth a closer inspection.

AW: What are some best practices when working toward compliance?

MR: Each site is unique with challenges specific to the history of the plants regarding CCR management. However, some key trends can help prepare for compliance. First, structure the team within the O/O organization to include key stakeholders and establish a partnership with the selected consultants supporting the efforts. Second, conduct an initial self-assessment of each facility to determine how the rule applies, what might be present, and how this will be managed over the next 5 to 10 years. While there may be additional areas of interest at a site, the majority of the likely CCRMUs are probably understood by your stakeholder team and planning can begin earlier in the process. Third, quickly and thoroughly collect the information needed to support the evaluation efforts, allowing a prompt and complete response to review the records. Fourth, develop a program schedule that allows the O/O to execute current tasks and plan for the overall process to reduce the potential for surprises. Finally, stay informed about industry and regulatory shifts in interpretation or approach and be ready to respond.

AW: What are some key challenges in responding to the legacy rule?

MR: Wow, this is a loaded question! Let me focus on some key challenges related to the purposeful implementation of the rule. I often say, "the only certainty in CCR management is regulatory uncertainty" and it is likely that this will continue to be a factor for many years. Those implementing the legacy rule would like a clear understanding of what needs to be done, how it will be reviewed and accepted, and this all sooner rather than later. The challenge of clearly and confidently knowing how to implement the legacy rule requires diligent attention to industry/regulatory practices and variability.

But to be more specific, let me highlight a few challenges with a bit more context (and in no specific order). First, the effort can reveal unknown or unexpected CCRMUs that require further evaluation and quick responses. Second, there may be a lack of information that clearly defines the extents of the CCR, requiring a more intensive data gap investigation. Third, at the risk of being redundant, regulatory uncertainty in the interpretation and application of the rule may result in interpretation that is out of alignment with the EPA's intent. Fourth, the absence of a permitting authority today that would facilitate a discussion about the application of the legacy rule and the pending creation of the permit authority sometime in the future. Not to mention, it is unclear how the permitting authority will interact with the O/O and possible new expectations that may be misunderstood in the rule. Note, the EPA has stated the permit rule would be issued in the fall 2024 as a final regulation (the comment period has already been completed). Finally, many legal cases are in the court system and, pending resolution, will impact the execution of the CCR rule.

AW: What final piece of advice do you have for people just getting started on compliance with the legacy rule?

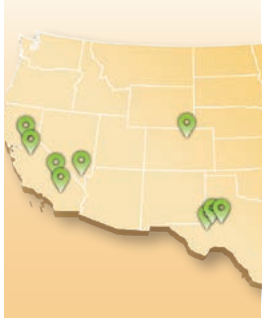
MR: Excellent note on which to end. My advice focuses on futureproofing: Be thorough and be prepared. There is a lot to do to comply with the legacy rule, and a permit authority will not likely be established and responsive for years to come. Being thorough in the process should reduce future efforts to evaluate the body of work. Being prepared for what is next will help manage efforts efficiently. This may include a master schedule with assignments, early estimates for closure, aligning the team as a partnership, etc., with the intent to stay several steps ahead. Finally, be ready to avoid unnecessary accelerated schedules and quick decisions, as change is still in the future.

About Burns & McDonnell

Working from more than 75 offices around the world, Burns & McDonnell designs and builds critical infrastructure. Our family of companies—driven by engineers, construction professionals, architects, planners, technologists, and scientists—deliver projects grounded in safety and a desire to make a difference as we make our clients successful. Founded in 1898, Burns & McDonnell is 100 percent employee-owned. Learn more: https://www.burnsmcd.com/

Additional Resources

- Blog: *Achieving Groundwater Compliance with Environmental Sequence Stratigraphy Methods* by Mark Rokoff
  https://blog.burnsmcd.com/achieving-groundwater-compliance-with-environmental-sequence-stratigraphy-methods
- White Paper: *Implications of EPA's Proposed CCR Rule Decisions* by Mark Rokoff and Jason Eichenberger
  https://info.burnsmcd.com/white-paper/implications-of-the-epas-proposed-ccr-rule-decisions
- Coal Combustion Residuals Management Service Page
  https://www.burnsmcd.com/services/electric-power-generation/environmental-compliance/coal-combustion-residuals-management



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EP Power Minerals

Editor's note: In this ongoing series, ASH at Work highlights ACAA member companies and the valuable products and services they provide.

EP Power Minerals is working to initiate long-term, environmentally friendly mining of natural pozzolan at Hjörleifshöfði, in Southern Iceland.

EP Power Minerals (EPPM) was founded in 1979 as Steag Entsorgungs-GmbH to develop recycling technologies for power plant byproducts, such as fly ash drying, and to deploy logistical assets to achieve near 100% utilization for its utility clients. The business has evolved into a global network with numerous joint ventures and subsidiaries to supply cementitious materials such as fly ash and granulated blast furnace slag to our worldwide customers in the cement and concrete industry.

Since 2021, EP Power Minerals has been part of EP Holdings (EPH), a leading European multi-utility company with a diversified investment portfolio in various industries to ensure resilience and stability in diverse market conditions. We are deeply committed to our communities and actively seek ways to adapt our businesses and infrastructure for a sustainable future.

EPH key performance indicators for 2023 include revenues of over $25 billion, an EBITDA of $3.8 billion, and assets totaling about $30 billion.

The accomplishments of EPPM companies include many firsts such as the reclamation of previously disposed fly ash and the deployment of "zero-disposal" strategies for German coal-fired utilities, which also included the commissioning in 2000 of the rapid dryer at Lunen, Germany, to process seasonally stored wet-condition fly ash from multiple power plants in the area.

Nearly 35 years ago, our France-based business, Surschiste, pioneered the reclamation and beneficiation of landfilled fly ash for concrete use. In 1989 at Hornaing, and the following year at Saint Avold, Surschiste began harvesting and processing fly ash from the two landfills to supplement fresh ash production to meet the construction industry's high demand for ash in summer. From 2010 onward, as current-production fly ash supplies throughout the country became increasingly scarce, harvesting at the two sites accelerated. By 2020, over 6 million tons of fly ash had been reclaimed, processed, and sold for use in concrete. In 2025, the Hornaing facility will undergo an upgrade to include beneficiation for carbon and fineness reduction. The upgraded facility will process the remaining on-site deposit and becomes a hub to process other nearby fly ash deposits to supply northern France and Belgium with reliable and high-quality SCM.

Our success in European markets and ongoing expansion has made us a major global supplier and trader of SCMs for the decarbonization of the built environment. Despite our global reach, we stay locally rooted through the efforts of our more than 10 subsidiaries and joint ventures.

For our next phase of growth, EP Power Minerals is committed to developing, building, owning, and operating new facilities in Europe and North America to produce SCMs. Currently, fly ash landfills, terminals, and natural pozzolan projects are being developed in the U.S., the UK, France, Poland, and Iceland to supply the market with SCMs such as fly ash, natural pozzolans, and GGBFS. Our mission is clear: We are investing in a solid future. We are investing in a sustainable future. We are investing in a reliable future. We are investing in a cementitious future.

www.eppowerminerals.com

EP Power Minerals:
Locally rooted and globally connected.

Expertise in all aspects of CCP and SCM handling, processing, use, and trading
Pioneered the reclamation and beneficiation of landfilled fly ash for concrete use
Pioneered close to 100% utilization of CCPs for German coal-fired utilities
Major global supplier and trader of SCMs for the decarbonization of the built environment

We make cementitious materials available. EP Power Minerals is your global expert for cementitious materials. We started out more than 40 years ago in Germany with the task of developing beneficial use strategies for power plant by-products, operating processing plants, and organizing the distribution of residual materials from power plants and other industries. With our global network and numerous subsidiaries, we have since evolved to become experts in managing cementitious materials such as fly ash and granulated blast furnace slag.

We care for a sustainable future. We care for a reliable future.
We care for a solid future. We care for a **cementitious** future.

We are hiring for the following positions: SCM Trading Manager for the U.S., Construction Manager for the U.K., and a Project Development Manager for Central and Eastern Europe. Contact info@mycoalashfuture.com for more information.

TENNESSEE VALLEY AUTHORITY

TVA Pioneers a New Gypsum Reslurry Process

Editor's note: In this ongoing series, ASH at Work highlights ACAA member companies and the valuable products and services they provide.

Photo of TVA's Cumberland reslurry process

As the coal industry evolves, TVA stays ahead of the curve, consistently adapting and pioneering new innovations and sustainable practices. The demand for coal-fired electricity generation may be trending downward, but the demand and need for coal combustion residuals (CCR) remains robust, underscoring the need for smarter, more sustainable management practices.

Since its founding in 1933, TVA has been leading the charge by anticipating future needs and advancing cutting-edge solutions that benefit both the industry and the communities it serves.

As the primary energy provider to 10 million people across Tennessee and six neighboring states, TVA's mission includes keeping the lights on for the communities it serves, creating economic opportunity, and protecting our environment and natural resources. TVA is committed to advancing sustainable practices, like the modernized harvesting of CCR materials, particularly gypsum.

TVA has redefined gypsum harvesting with a technique called "reslurrying." This technique takes previously placed gypsum from the gypsum stack, loads it into a hopper, and conveys it to a mixing tank where water is added to the gypsum. This allows the harvested gypsum to be sent to the gypsum processing plant in the same manner as freshly produced gypsum slurry from the power plant. The gypsum processing plant reduces the moisture and fines content of the gypsum before conveying it to the wallboard plant, which eliminates common production issues, saving the wallboard plant from costly delays due to overly wet material. The result is greater efficiency, higher-quality gypsum, and fewer disruptions.

Since 2022, TVA has successfully beneficially used over 2 million tons of gypsum, with nearly one-third of that being harvested to meet market demand. This monumental achievement not only reduces waste, but also repurposes materials for economic development, avoiding landfilling and supporting job creation.

At TVA's Cumberland and Kingston plants, gypsum harvesting has become a cornerstone of their beneficial reuse operations. Whether supplying gypsum to a nearby wallboard plant or one that is hundreds of miles away, the beneficial use of harvested gypsum has created a ripple effect of economic benefits across the Tennessee Valley.

Even as the industry faces new challenges, TVA's leadership in CCR harvesting—especially reslurrying—remains a critical factor in sustaining the supply chain. By continuing to avoid unnecessary landfill use and championing sustainable practices, TVA is creating opportunities for future growth and development while adapting to the changing coal generation landscape.

At its core, TVA is driven by a simple mission: to serve the people of the Tennessee Valley. Through its industry-leading practices, TVA is not only reshaping how gypsum is harvested, but also setting a new standard for sustainable innovation, all while keeping customers and the environment at the heart of everything it does.

THE OHIO STATE UNIVERSITY

ASH Allies: The Ohio State University Harvested CCR Program

The Ohio State University's Coal Combustion Products Program has been working since 1996 to promote the beneficial uses of coal combustion residues (CCRs) through research, outreach, and engagement. In January 2024, the university began a renewed focus on harvested CCRs over the next five years.

The primary objective of this program is to collaborate with the CCR industry in the development, assessment, and technology transfer of promising harvested CCRs for commercial and end-use sectors while providing workforce training and retention. The program advances the productive and economical use of ponded fly ash and landfilled fly ash, bottom ash, and flue gas desulfurization (FGD) materials at disposal sites.

The program addresses the needs of the harvested CCR industry and advances the technically sound, environmentally friendly, commercially competitive uses of harvested CCRs in many interdisciplinary sustainable applications. The program aids the harvested CCR industry through research, education, technology transfer, and outreach in its efforts to:

1. Develop new or under-used market applications (such as fly ash concrete, cement-free bricks, aggregates, etc.);
2. Expand use in proven areas (such as mine reclamation);
3. Advance high-value uses of harvested CCRs (such as extraction of rare earth and valuable elements);
4. Place greater emphasis on high-volume and/or high-value markets;
5. Remove or reduce regulatory and perceptual barriers to use; and
6. Focus on developing alternative green construction certification frameworks.

We expect to showcase that non-productive CCRs disposed of in ash ponds and landfills generated by coal-fired power plants (whether active or defunct) can be harvested and used in high-volume and high-value applications in a manner that is economically viable and beneficial to the environment, the public's health and safety, and the generating companies/owners.

The Ohio Coal Development Office funds this program at the university in collaboration with more than 50 industrial co-sponsors, including the American Coal Ash Association, Midwest Coal Ash Association, Utility Solid Waste Activities Group, Electric Power Research Institute, Tennessee Valley Authority, American Electric Power, Ohio Valley Electric Corporation, Southern Company, and Ohio Coal Association.

To join this strong coalition of industrial partners promoting the beneficial use of harvested CCRs at Ohio State University, please contact Dr. Tarunjit Singh Butalia, Research Associate Professor, at butalia.1@osu.edu.

OSU Harvested CCR Open House, hosted at Brixx Facility in Toronto, Ohio, on September 25, 2024. The plant produces cement-free blocks, bricks, and aggregates from fly ash harvested from a nearby disposal site.

ASH Classics

A Look Back at the Beginnings of the U.S. Coal Ash Industry

"ASH Classics" is a recurring feature of ASH at Work that examines the early years of the American Coal Ash Association and its predecessor, the National Ash Association (NAA), focusing on issues and events that were part of the beneficial use industry's defining years.

While much attention is now focused on harvesting of previously disposed ash to help meet construction industry demand, in 1980 our industry faced the opposite challenge: trying to generate demand for CCPs. One story in the following ASH Classic reports on NAA efforts to "acquaint utility personnel with ash utilization concepts and technology," while a second describes how the first use of fly ash on a highway project in Ohio "made believers" out of the contractor and DOT project supervisor, who had been "leery of the material."

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NAA Conducts Ash Utilization Seminar For 32 PP&L Engineers

ALLENTOWN, PA—Thirty-two engineers on the staff of Pennsylvania Power & Light Company participated in an in-house Ash Seminar here presented by the National Ash Association designed to acquaint the utility personnel with ash utilization concepts and technology.

The one-day session introduced the NAA's training program now available to assist member companies in coping with the problem areas facing the ash industry ranging from ash management, environmental concerns, applications, to marketing.

Executive Director Jim Covey reiterated the association's services are available upon request. In fact, Michigan Foundation Company, Inc.—one of newest members has already requested aid in presenting a program for highway engineers in the Trenton, Mich. area.

Subjects covered at the PP & L seminar included use of ash in structural fills and embankments, highway and pavements, fly ash concrete, and other construction applications. A review of the utilty's Polymer Concrete Research concluded the program.

Clark Harrison, supervisor—ash marketing for PP & L, coordinated the program. Participating departments included construction, power plant engineering, fuel supply, power production, bulk power engineering, environmental management, engineering services, technology and energy assessment.

Staff personnel were encouraged to ask for ash to be used on in-house construction projects.

PP & L followed up the seminar with a feature story in its company magazine, "PP & L Reporter." The story, titled "Turning Trash Into Treasure," reviewed the company's ash program and

(Continued on page 2)

MAKES POINT—*NAA Consultant John H. Faber stresses the need for the adoption of a company-backed ash management program to foster the increased use of power plant ash in remarks before PP & L staff engineers.*

BULLETIN

WASHINGTON—Ash collection in 1979 soared to a record 75.2 million tons, according to data compiled by the National Ash Association in cooperation with the Edison Electric Institute. The total is 7.1 million above the figures for the previous 12-months.

The components include 57.5 million in (48.3) fly ash, 12.5 million (14.7) in bottom ash, and 5.2 million (5.1) in boiler slag.

During the same period ash utilization slipped almost one percent to 23.0% of total ash collected. The 1978 use totals reached 24.1—an all-time peak.

IN THIS ISSUE

Charter Members Are Back In NAA Fold

Four utilities, including two former charter members, have joined the National Ash Association along with a western coal producer and six (6) other non-voting members, according to Executive Director Jim Covey.

Commonwealth Edison Co. of New York, Inc. and Dayton Power & Light Company of Dayton, Ohio are back in the fold as participating members following an absence of several years, Covey said.

Con Ed's Vice President John A. Nutant is the firm's designated board member and Howard P. Palmer, vice president—environmental management, will represent the Ohio utility.

Orange & Rockland Utilities, Inc. of Pearl River, NY and Con Edison are the first to join the NAA under the new membership category for ash producers converting stations for oil to coal-fired generating or developing new fossil fuel plants. B. Z. Baxter, director-power development, is the board designate for Orange and Rockland.

The second new utility member is New York State Electric & Gas Company headquartered in Binghamton, N.Y. Jeffrey K. Smith is the firm's representative on the Board of Directors. The company currently operates five coal-fired stations and has an interest in the Homer City Station in Homer City, PA.

The new members include a western coal producer, Wyoming Fuel Company of Lakewood, CO, Covey related. "The coal producer has a real stake in the overall ash management program and we are delighted to have Wyoming Fuel as a participating member," he added. Market Analyst David H. Hebb is the firm's designated board member.

(Continued on page 2)

Seminar . . .

(Continued from page 1)

marketing potential for 1.5 million tons it produces annually.

The speakers emphasized the importance of managing these coal by-products as a resource and not a "waste material." PP & L's marketing slogan is shown in the above insert.

Panelists included John Faber, consultant to the NAA; Dr. Roger K. Seals, chairman Department of Civil Engineering at Louisiana State University; Dennis L. Kinder, research engineer for American Electric Power Service Corporation; Mike Shydlowski, sales engineer for American Admixtures; Alan G. Richenbacher, senior project engineer for PP & L, and Co-ordinator Harrison.

NAA CONDUCTS ASH SEMINAR FOR PP & L EMPLOYEES—*Pennsylvania Power & Light Company recently sponsored a seminar on ash technology for 32 staff engineers to acquaint them with the benefit of increased ash utilization. John Faber is shown addressing group. Other panelists were (First Row, left to right) AEP's Dennis L. Kinder, Dr. Roger Seals of LSU, PP & L's Clark Harrison; and (Second row, foreground) Mike Shydlowski of American Admixtures.*

AEP Sets

Ash Use Review For ODOT Staff

COLUMBUS, OHIO—Seven ash industry representatives recently met with officials of the Ohio Department of Transportation to again review applications of power plant ash in highway construction.

The session was set by Dennis L. Kinder, a research engineer with American Electric Power Service Corp., and Russell Catlin, Executive Assistant to ODOT Director David L. Weir. Three earlier meetings, the first in 1976, were coordinated by the National Ash Association.

The presentation centered around a review of present uses of these coal by-products in highway applications and the availability of ash in Ohio. Thirty-six ash producing power stations were identified for ODOT officials.

Bob Smith of John Tonkovich & Son, Inc. also described the placement of a fly ash embankment in Belmont County —Ohio's first major use of ash on a road project. (See story on Page 3).

The ODOT was advised that an engineer attached to AEP's Ash Utilization and Research staff will be assigned the responsibility for marketing the ash produced by Columbus & Southern Ohio Electric Company's five major power stations.

ODOT staff members present were Mr. Catlin; Assistant Director Clark Street; Warren Baas, chief engineer construction; Fred Behn, bureau of research and development; John Paxton, G. Phillip Hall, and Rodney Koeing, bureau of tests; Joseph Stahovec, and Woody Anderson, bureau of construction; Rick Engel and Walter Florence, bureau of bridges; Ken Miller, bureau of location and design; and Ronald Zook, bureau of maintenance.

Ash industry reps included Messrs. Kinder, Mark Pennington, and Rusty Nida of AEP; Al Babcock, Monongahela Power Company; John Ashby and Harry Schak, Pozzolanic, Inc.; and Mr. Smith.

C&SOE Becomes 8th AEP Operating Unit

COLUMBUS, OHIO—Columbus and Southern Ohio Electric Company is now the American Electric Power System's eighth operating Company and the acquisition added five coal-fired generating stations to AEP's 15 major power plants located in seven eastern and mid-western states.

Additionally, AEP is completing the transfer of its corporate executive offices to Ohio's capitol city. A total of 440 persons are involved in the relocation from New York City. The staff is being temporarily housed in the Borden Building while a new facility is erected in the downtown Columbus area.

Robert S. Hunter, executive vice president of AEP's Service Corporation, will be the company's senior officer in New York. He will continue to direct the system's major construction program in addition to his new administrative duties.

The purchase was effected 12 years, three months, and 17 days after the two utilities announced their merger plans.

C & SOE's major stations were identified as Conesville, Poston, Walnut, Picway and Stuart. The latter unit is jointly owned with the Cincinnati Gas & Electric Co. and Dayton Power & Light Co.

The other operating companies comprising the AEP system include Appalachian Power Co., Indiana & Michigan Electric Co., Ohio Power Co., Kentucky Power Co., Kingsport Power Co., Michigan Power Co., and Wheeling Electric Co.

Charter Members . . .

(Continued from page 1)

The six other members include Mid-Atlantic Ash Co., Salis., Md.; Abrasive Aggregates, Inc., Ft. Lauder., Fla.; MI Foundation Co., Inc., Tren., MI; Peabody Process Systems, Inc., Stam., CT; Solel Boneh, Ltd., Tel-Aviv, Israel; and SRI International, Menlo, Park, CA.

Fly Ash Embankment Makes "Believers" of Contractor, ODOT

POWHATTAN POINT, OHIO—The first use of fly ash on a highway project in the State of Ohio has made believers out of the contractor and the Department of Transportation's project supervisor.

The initial experience took place in an embankment around a concrete bridge over the Pennsylvania Railroad at the intersection of Routes 7 and 148 near here. Over 5,658 tons of ash were placed in the fill around the abutments.

To date the only other use of power plant ash by the DOT was on a bicycle path in the Dayton area which was also completed in the 1979 construction season.

Both the supervisor, Ron Baker, and Project Manager Clarence Arno were "leary of the material" when they started the fill but upon completion of the work were highly impressed with its "workability." Sutton and Stewart, Inc. of Bridgeport were the general contractors.

The ash was supplied by John Tonkovich & Son from Ohio Edison's Burger Station located about five miles north of the job site.

The fill started out about four feet below the railroad grade in a confined area that made compaction somewhat difficult. At the deepest point the ash embankment was 27 feet high and extended longitudinaly about 80 feet. The ash was placed in six-inch lifts initially and as the width of the fill expanded the material was compacted in 12-inch lifts.

Arno described the fill area like "working in a 30-foot box." "There was just no way we could have gotten compaction in an earthen fill in this situation without a lot of hand tamping," he added.

Fly Ash Delivery

The veteran contractor stated the amount of ash "worked out closer in planned quanity than any material we have ever used." With soil you have to add 15 percent, Arno explained.

The DOT inspector confirmed the ash "didn't demonstrate the shrinkage you would normally have with dirt or gravel." Compaction attained 95% of standard proctor or 100 percent density.

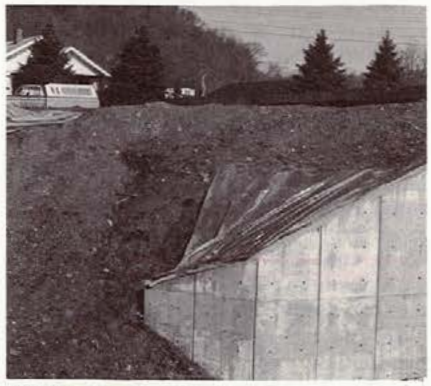
The job specs called for the placement of two feet of 310 mill slag against the bridge abutment which had been coated with an asphalt preparation. Additionally, a celanese filter cloth (Mirafi) was placed between the slag and the fly ash for the full height of the fill.

The outslopes were covered with a soil cover as the fill was placed to minimize possible erosion and spillage on the railroad tracks. This was very important as it was necessary to maintain rail traffic at all times.

Arno also emphasized he had no "shut down time" while placing the ash. The contractor finished one side in mid-December and the other on March 16. "If the ash fluffed or dried out a little we simply ordered a wet load of ash which corrected the problem immediately," Arno related in praising the cooperation of ash supplier.

However, Baker concluded he wouldn't recommend ash placement in temperatures below 30 degrees because of "the problem of getting the ash out of the truck bed."

Little or no settlement has been noted in the fill since the sub-base and wearing course was placed and the road opened to traffic last spring.



Filter Cloth Used

Ash Being Compacted

Completed Ash Fill

Overall View of Embankment Site

Massachusetts Is First Ash User In Northeast

NORTON, MASS.—Power plant bottom ash has received high marks thus far from Massachusetts highway officials here as a replacement for sand and gravel in the base layer of a section of John Scott boulevard.

The Boston Sunday Globe recently referred to the application as the first of its kind in the Northeast.

"The road isn't open to traffic yet, but I think the ash experiment is going to work out pretty well," Highway Superintendent Carl Jacobs told reporter Bill Laberis.

"It hasn't settled anymore than gravel would have and it stood up well to the frost last winter," he added.

Last August, crews placed 1,800 cubic yards of "gritty coal ash" from New England Power Company's Bayton Power Station in Somerset on the road base.

The news article said the ash, under most circumstances, would have been hauled to the utility's landfill in Freetown at a cost of $3.20 per ton. "Until recently," the story related, "the gray-black coal ash was a worthless waste with nowhere to go but back from where it came, deep down under as landfill."

In the lengthy story, Laberis used production and utilization figures supplied by the National Ash Association and cited the mineral extraction research now being carried out at the Oak Ridge National Laboratory in Tennessee.

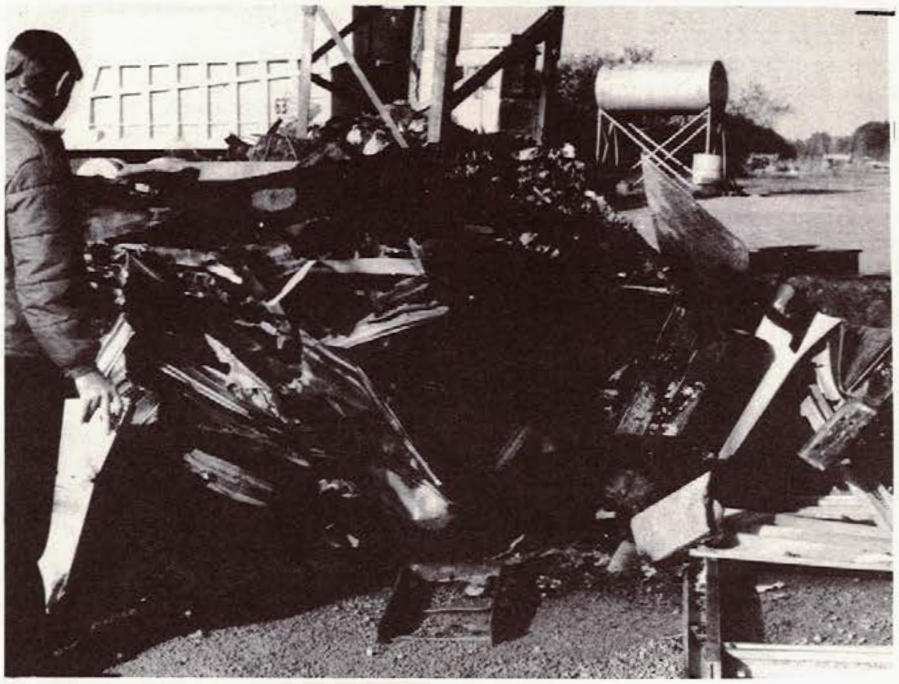
The successful use of ash by the West Virginia Department of Highways in similiar applications was also noted in the Laberis report.

He said, in part, "The inert, solid ash has already been used to replace sand and gravel in the base layer of literally hundreds of miles of roads in West Virginia. Tests conducted by the West Virginia Department of Highways have shown that coal ash has a strong bonding affinity for asphalt. Since 1972, the department paved more than 300 miles of country roads with a mixture of coal ash and emulsified asphalt called 'ASH-PHALT'."

The story concluded "with stricter guide-lines regarding the dumping of industrial wastes and with greater domestic coal consumption, the presence of million of tons of coal ash could pose yet another costly disposal problem for power companies and heavy industry.

"A new technology which uses coal wastes is, however, emerging from the piles of ash born largely out of the economics of inflation."

Fire Fails To Halt Fly Ash Deliveries



FIRE DESTROYS ASH PLANT—Plant Superintendent Woody Woodall surveys the charred remains of Gifford-Hill's fly ash plant at Cason, Texas. The facility was back in operation within two days. (Photo and story, courtesy Gifford-Hill "TIMES," May 1980)

CASON, TEXAS—Fly ash marketers are a hardy lot, particularly the Texans that operate Gifford-Hill's fly ash plant here.

On Friday night, March 7, a drunken driver rammed his car through a locked steel gate at the plant and continued on several hundred feet before severing a power pole. The resultant fire totally destroyed the office and storage building, but by Monday morning it was "business as usual."

By Sunset on Saturday, Ash Products Manager Claude Brown, Plant Superintendent Woody Woodall, and Glen Womack—husband of Cason Secretary, Mickie Womack—had the debris cleared, the bottom ash filled in and leveled, and red telephone was on the bare ground about 50-feet from the charred automobile which had caused the fire. The power company had set two new poles and restored service as well.

On Sunday, a new portable building was delivered to the yard. And Calvin Hall, Mickie's father, wired in the new electrical service. Woody's wife, Nora, got into the act and showed up with some office furniture from home.

The scale people arrived on Monday. A Porta-Potty was also sited. And by week's end, the dedicated crew had managed to ship 1,000 tons of fly ash.

Gifford-Hill & Company, Inc. is an active member of the National Ash Association. Claude K. Brown of Dallas, Texas, Manager Ash Products, has represented Gifford-Hill at many NAA sponsored symposia and technical meetings.

COVEY'S COMMENTS:

Ash management is not as easy as it sounds. Two of the basic corollaries to Murphy's law aptly referring to the subject are that every solution breeds new problems and Nature always sides with the hidden flaw.

Get The Facts. . . . . Join The N.A.A.!

In and Around ACAA

Lexington, Kentucky

(L-R): Danny Gray, Eco Material Technologies; Chris Bergin, Troutman Pepper; Ken Daly, Burns & McDonnell; and Bob Jewell, UK-CAER, at ACAA's Fall Conference.

Grand Rapids, Michigan

(L-R): Matthew Wachholz, Schnabel Engineering, and Craig Schuettpelz, WSP, at the World of Coal Ash.

Euless, Texas

(L-R): John Anderson, American Concrete Institute (ACI) Northeast Texas Chapter President; Thomas Adams, ACAA Executive Director; and Garrett DeGeare, ACI Northeast Texas Chapter Vice President.

Lexington, Kentucky

Members of the ACAA's Women's Leadership Forum meet for a luncheon during ACAA's Fall Conference.

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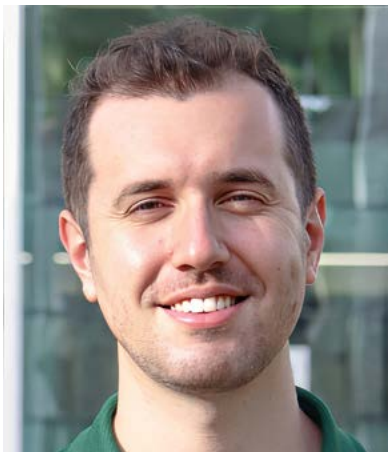
2024 ACAAEF Scholarship Winners Selected

The American Coal Ash Association Educational Foundation distributed $17,500 in scholarship awards to three graduate students and one undergraduate with an interest in the management and beneficial use of coal combustion products. Receiving $5,000 David C. Goss Scholarship awards were Luca Galli, Ph.D. candidate at the University of Miami; Ting Liu, Ph.D. candidate at the Georgia Institute of Technology; and Yu Tan, Ph.D. candidate at the University of Wisconsin–Madison. Samuel Wright, senior at the University of Louisville, received a $2,500 John Faber Scholarship.



David C. Goss Scholarship Winner

Luca Galli, University of Miami

Essay: "The Phoenix of Coal Power Plants: How Human Ingenuity is Giving Unconventional Fly Ash a New Rise"

Abstract: "This essay explores the success story of fly ash, a coal byproduct transformed into a vital construction material, reducing waste and promoting a circular economy. With the decline of coal-fired plants, the future of fly ash is threatened. Yet ingenuity can benefit us. Stockpiled 'unconventional' fly ash offers a viable solution. Though reclaimed ash requires processing, recent research demonstrates its potential to achieve performance comparable to conventional fly ash. By embracing past successes and utilizing these alternative sources, we can continue our legacy of sustainable resource management."

David C. Goss Scholarship Winner

Ting Liu, Georgia Institute of Technology

Essay: "Extraction and Separation of Rare Earth Elements from Coal Fly Ash Using Ionic Liquids"

Abstract: "Our research group has demonstrated a method that selectively extracts rare earth elements (REEs) from coal fly ash using a recyclable ionic liquid (IL), betainium bis(trifluoromethylsulfonyl)imide ([Hbet][Tf2N]). My recent work successfully applied the method to six different types of CFA, confirming the process' high selectivity of REEs over bulk and trace elements. Ongoing and future research will focus on: (1) applying the IL-based REE recovery method to coal ash leachate; (2) evaluating the economic feasibility of this lab-scale method; and (3) separating scandium after IL extraction. The significance of this research extends beyond merely improving REE extraction. Using IL to recover REEs from coal combustion products can provide a promising solution for a sustainable REE supply."

David C. Goss Scholarship Winner

Yu Tan, University of Wisconsin–Madison

Essay: "Which Are More Sustainable Strategies to Manage CCP Legacy in Surface Impoundments: Removal, Close-in-Place, or Beneficial Use?"

Abstract: "Life-cycle assessment was conducted to evaluate the environmental impacts of strategies used to manage coal combustion products (CCPs) disposed in unlined surface impoundments. Life-cycle inventories were compiled from reports published by the Electric Power Research Institute and the Environmental Research & Education Foundation, as well as from numerical simulations I conducted in my research at the University of Virginia and the University of Wisconsin–Madison. My findings suggest that removal of CCPs from basins and placement in lined landfills results in more freshwater pollution than unlined surface impoundments. These findings indicate that a site-specific environmental impact assessment is needed before removing CCPs to ensure that the removal option has net environmental benefits. In many cases, closure-in-place may be a promising alternative that protects local groundwater and minimizes global environmental pollution. Beneficial use of legacy CCPs is even more favorable, as releases to freshwater as well as other emissions are reduced."

John Faber Scholarship Winner

Samuel Wright, University of Louisville

Essay: "The Use of Fly Ash in the Creation of Geopolymer: An Environmentally Friendly Building Material for High Early-Strength Concrete in Precast/Prestressed Concrete"

Abstract: "One of the biggest challenges facing modern society is the rapidly increasing carbon emissions in our atmosphere. Concrete producers are largely responsible for about 8-10 percent of the total carbon emitted into the atmosphere, highlighting the need to find more sustainable methods of producing such building materials. Geopolymers have been shown to offer a great alternative solution. Unlike traditional cement-based concrete, geopolymers incorporate carbon into their structure, thus resulting in a net-zero carbon emission production process. Geopolymers have been shown to have other strengths over traditional concrete, such as higher compressive strength and better resistance to wear from heat, acids, and salts. Fly ash plays a crucial role in the production of geopolymers due to its alumina- and silica-rich makeup. What makes the research of geopolymers so interesting is that not only do they work towards finding a more sustainable building material, but they do so while using industrial byproducts, resulting in multiple ways of environmental healing and necessitating our further understanding of the material."

Applications were reviewed and rated by multiple judges based on course work, grades, recommendations, career goals, and essays. ACAA thanks the following member volunteers for participating in the evaluation process: Travis Collins, National Minerals Corporation; Mark Rokoff, Burns & McDonnell; Mindy Ward, Eco Material Technologies; Doug Rhodes, Eco Material Technologies; John Trast, GEI Consultants; John Tiberi, Ashcor; and Thomas Adams, ACAA.

ACAAEF was established by the American Coal Ash Association to promote understanding of the management and beneficial use of coal combustion products through scholarship awards, development and distribution of educational materials, support of targeted research, and sponsorship of educational forums. The ACAAEF Board comprises Chair, John Halm, Duke Energy; President, Thomas Adams, ACAA; Secretary/Treasurer, Travis Collins, National Minerals Corporation; Director, Dale Diulus, Salt River Materials Group; Director, Ivan Diaz, Eco Material Technologies; Director, Anne Oberlink, UKY-CAER; Director, Russell Stapp, Eco Material Technologies; and Director, John Trast, GEI Consultants.

Welcome, New ACAA Members!

Babst Calland has more than 35 years of experience in handling domestic and international environmental and regulatory and transactional matters. The firm's attorneys have extensive experience with industrial operations throughout the country, particularly in the areas of electric power generation, transmission and distribution, coal, natural resources, primary and secondary metals, chemicals, and heavy manufacturing. Each attorney practices in specific areas of concentration, such as air and water pollution, industrial and municipal wastewater management, hazardous and solid waste disposal, complex site remediation, natural resource damages, transactions, regulatory compliance, and occupational safety and health. Headquartered in Pittsburgh, Babst Calland joins as an Associate Member. For more information, please visit www.babstcalland.com.

Carbon Negative Solutions creates carbon-negative supplementary cementitious materials (SCMs) that are upcycled from zero-value waste streams, resulting in a product that is cleaner, costs less to produce, and replaces more cement (> 50 percent) than traditional SCMs. Headquartered in Somerville, Massachusetts, Carbon Negative Solutions joins as an Associate Member. For more information, please visit www.carbonegativesolutions.com.

Carrier Process Equipment Group Inc. comprises four companies (Carrier Vibrating Equipment, Heyl Patterson Thermal Processing, Sly, and S. Howes) and works closely with coal combustion product marketers and producers to reclaim, beneficiate, and process CCPs for cementitious and other uses. The company designs and manufactures products and systems such as dryers, calciners, screeners, conveyors, and dust collectors, among others. Headquartered in Louisville, Kentucky, Carrier Process Equipment Group joins as an Associate Member. For more information, please visit www.cpeg.com.

Fives FCB specializes in the design, supply, and installation of core process technologies in the fields of crushing, grinding, drying, classification, flash calcination, pyroprocess, control, and optimization. The company's expertise ranges from equipment supply to comprehensive turnkey plants, including upgrades and customer services. Fives FCB's solutions focus on reducing the clinker factor, optimizing the production of blended cements by incorporating supplementary cementitious materials such as calcined clays, fly ash, and slag. Additionally, the company is developing advanced technologies to facilitate carbon capture and storage. Fives FCB joins as an Associate Member. For more information, please visit www.fivesgroup.com/cement-minerals.

GCP Applied Technologies is a premier national supplier of chemical admixtures to ready-mix concrete companies, and cement additives to the world's cement producers. GCP partners with producers, contractors, designers, and engineers to achieve performance and sustainability goals. Headquartered in Alpharetta, Georgia, GCP Applied Technologies joins as an Associate Member. For more information, please visit www.gcpat.com.

Heyl Patterson Thermal Processing, LLC provides thermal processing equipment for the drying and beneficiation of fly ash so that it may be used as a supplementary cementitious material. The company's range of dryers are designed to remove moisture or solvents from solid materials through the application of heat. These dryers are highly efficient, reliable, and customizable, making them ideal for a variety of applications, including drying grains, minerals, chemicals, and waste products. Headquartered in Carnegie, Pennsylvania, Heyl Patterson Thermal Processing joins as an Associate Member. For more information, please visit www.hpprocess.com.

Martlin Distributing manufactures patented, high-performance drying products specifically designed to minimize waste and reduce cycle costs while effectively managing liquid spoils, i.e., sludge, sediments, drill cutting, and coal combustion residuals. Headquartered in Carnegie, Pennsylvania, Martlin Distributing joins as an Associate Member. For more information, please visit www.martlindistributing.com.

OTB Materials Corp.'s innovative production processes enable it to provide the construction industry with alternative concrete materials that significantly reduce carbon emissions and with improved performance at a comparable cost. By harnessing the power of waste sulfur and leveraging patented technology on fly ash beneficiation, the company is transforming byproducts into valuable resources, mitigating environmental impact and leading the charge towards a greener tomorrow. Headquartered in Elmhurst, Illinois, OTB Materials Corp. joins as an Associate Member. For more information, please visit www.otbmaterials.com.

ProtectGD, LLC holds a technology under patent US 11,629,097 B2 that can compress coal ash pellets to significantly reduce the leaching of toxic substances such as arsenic, cadmium, and mercury by tens to hundreds of times. Headquartered in Bellevue, Nebraska, ProtectGD, LLC joins as an Associate Member.

RB Jergens is a mid-sized general contractor that performs a wide variety of environmental and civil construction projects. The company specializes in coal combustion residuals work, which includes landfill construction, wet CCR impoundment closures, CCR management at active power plants, and other heavy civil/environmental power generation construction projects. The company has worked for various power utilities, state EPA agencies, highway divisions, local municipalities, national design-build firms, and waste disposal companies. Headquartered in Vandalia, Ohio, RB Jergens joins as an Associate Member. For more information, please visit www.rbjergens.com.

Rivalia Chemical Co. is a startup company pioneering new chemical extraction technology to solve two important problems: critical mineral scarcity and coal ash waste management. Rivalia harvests rare earths from ash, then transforms the residual ash for use in green concrete. Founder Laura Stoy is currently a Department of Energy Chain Reactions Innovations Fellow and has raised over $1 million in nondilutive funding to develop the technology. Rivalia Chemical Co. joins as an Associate Member. For more information, please visit www.rivaliachemical.com.

News Roundup

EPA Legacy Coal Ash Rule Updates

The U.S. Circuit Court of Appeals for the District of Columbia on November 1, 2024, declined to stay the U.S. Environmental Protection Agency's May 2024 legacy coal ash rule, letting it take effect while utilities and others challenge it in court.

Meanwhile, EPA on October 31, 2024, issued a direct final rule and companion proposed rule to correct errors in the final rule. The changes reflected in the direct final rule and companion proposal are:

- Fixing an error that caused confusion regarding the November 8, 2024, effective date of the Legacy Final Rule.
- Correcting inadvertent deletions in existing 2015 regulatory text caused by incorrect amendatory instructions.

EPD Grant Received

The American Coal Ash Association on July 16, 2024, was part of a partnership selected by the U.S. Environmental Protection Agency to receive $2.4 million to assist in improving both the quantity and quality of cement and concrete industry Environmental Product Declarations. EPDs are the most widely used tools to measure the potential environmental impact of concrete ingredients.

The EPA grant application was led by the Portland Cement Association (PCA) and included participation by ACAA, the Natural Pozzolan Association, and the Slag Cement Association. It will significantly boost the number of facility-specific EPDs for cementitious materials, which will upgrade the quality of information available for consumers.

The project will entail PCA distributing up to $1.5 million in grants to eligible manufacturers over the next five years. The association will also provide training and on-call technical assistance to guide manufacturers from EPD development to verification to the final publishing of the information. Additionally, PCA will help initiate and regularly update industry-average EPDs for cementitious materials.

EPA awarded a total of $160 million of Inflation Reduction Act funds to support clean U.S. manufacturing of steel and other construction materials. Other entities in the cement and concrete space receiving grants included:

- Heidelberg Materials US Inc. – $5 million
- Holcim US Inc. – $1.4 million
- National Ready Mixed Concrete Association – $9.6 million
- National Stone, Sand, and Gravel Association – $9.6 million
- Oldcastle Infrastructure Inc. – $4 million
- Prestressed Concrete Institute – $10 million

FHWA Promotes Industrial Byproducts Use

The U.S. Federal Highway Administration published "Use of Industrial Byproducts in Concrete Paving Applications," outlining considerations to be taken into account by highway agency and contractor engineers in evaluating the beneficial use of such products, including off-spec fly ash and bottom ash, in concrete paving projects.

Historically, bottom ash, as well as fly ash that does not meet AASHTO M 295 or ASTM C618 standards for use in concrete, has been landfilled or impounded. However, as coal power plants continue to be retired, limiting the availability of fresh production ash, landfilled/impounded fly ash and bottom ash (frequently comingled) are increasingly being harvested and beneficiated for use in concrete construction.

FHWA's report covers the basic physical and chemical characteristics of fly ash and bottom ash and their potential for use in a variety of bound (concrete) and unbound (fill and base material) applications, concluding: "Used alone or blended with other materials, off-spec coal ash can possess the chemical and physical characteristics needed to provide benefits for concrete and stabilized bases. Off-spec coal ash has been found to be a suitable material for use in stabilizing soils, with high-CaO off-spec ash showing better performance than fly ash meeting AASHTO M 295 (ASTM C618) in stabilizing some soils."

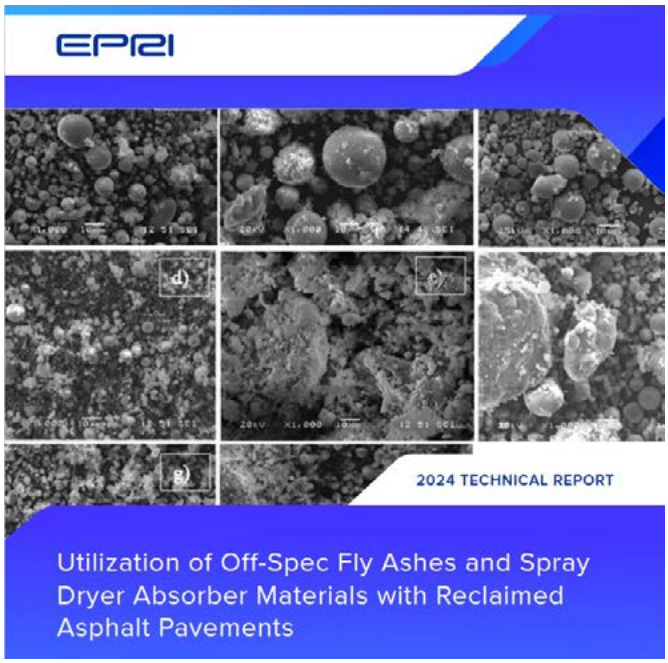
Once a material—whether coal ash or other byproduct—has been identified with the potential for beneficial use in a specific concrete paving project, FHWA says that the technical performance, economic feasibility, and environmental impacts of the material's beneficial use should be analyzed. "Tests should be performed on the material itself and on the application product (e.g., base, fill, or concrete material) during the qualification/preconstruction phase and upon delivery or during construction," FHWA says. The economic benefits can be quantified using a life-cycle cost analysis, while the environmental impacts and benefits can be evaluated using a life-cycle assessment, the agency adds.

EPRI Study Shows Off-Spec Ash Potential

The Electric Power Research Institute published a new, free Technical Report on "Utilization of Off-Spec Fly Ashes and Spray Dryer Absorber Materials with Reclaimed Asphalt Pavements."

The study investigated the use of off-specification fly ashes, including spray dryer absorber materials, fly ashes with duct injection products, and a circulating fluidized bed fly ash, in asphalt pavement. The focus of the study was interaction between ashes, rejuvenators, and reclaimed asphalt pavement.

Initial testing investigated the interaction of eight ashes and two asphalt mastics. A reduction in oxidative aging was identified in most of the blends, suggesting that the ash acts as an additive. Further testing with aged binders and four promising ashes from the initial testing showed mixed benefits from ash alone. Many combinations of ashes and rejuvenators exhibited synergy, but synergy was also dependent on the asphalt binder. Final testing showed that ashes plus rejuvenator generally improved the workability of pavements while meeting the adopted limits for high-, intermediate-, and low-temperature performance. The results demonstrate the potential for utilization of off-spec ashes as an asphalt pavement additive, as well as the potential for delivering blended ash plus rejuvenator products for use with reclaimed asphalt pavement.

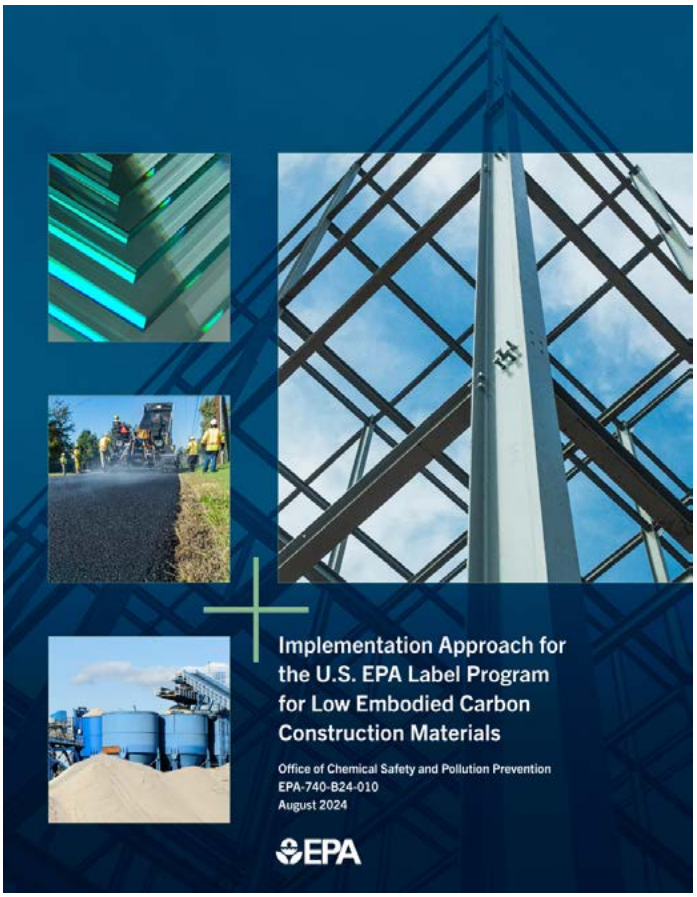


SEFA Rebrands to Heidelberg Materials

In May 2023, Heidelberg Materials announced the acquisition of The SEFA Group, further strengthening the company's cementitious footprint in the Southeastern U.S. market. SEFA will formally rebrand to Heidelberg Materials in January 2025, one global brand with an innovative portfolio of sustainable building materials as well as intelligent digital solutions.

Two years ago, the company unified the many legacy brands of Lehigh Hanson in North America under the Heidelberg Materials brand to better reflect its expertise in heavy building materials. The move also conveyed Heidelberg's broader focus beyond cement and aggregates and its journey to become the most sustainable company in its sector.

According to Chris Ward, President and CEO of Heidelberg Materials North America, SEFA's core business of processing and marketing fly ash for recycled, beneficial use in concrete fits into Heidelberg Materials' vision to build a more sustainable, circular, and resilient future. The addition of fly ash as a supplementary cementitious material helps reduce the CO2 intensity of concrete. SEFA is also uniquely qualified to offer a wide range of solutions to remove and recycle coal ash for beneficial use, with over 25 years' experience operating beneficiation facilities.



EPA Clean Labeling Plan Announced

The U.S. Environmental Protection Agency on August 7, 2024, announced its plan for implementing a new label program for cleaner construction materials and products.

The new label program will be funded by $100 million from the Inflation Reduction Act. It builds on EPA's selection of 38 organizations in July to collectively receive nearly $160 million to help businesses develop Environmental Product Declarations (EPDs), which report climate impacts linked to the production of construction materials and products. (American Coal Ash Association was one of the organizations selected to receive EPD funding.)

The label program will define what constitutes "clean" construction materials in support of the government's Federal Buy Clean Initiative, which aims to grow the market and reward innovation for American-made, lower-carbon construction materials. EPA anticipates that labeling requirements for each product type will be periodically reviewed and updated every two to four years to respond to and drive market shifts and help users meet sustainability objectives. The Inflation Reduction Act also provides more than $2 billion to the General Services Administration to use clean materials in the construction and renovation of federal buildings and $2 billion to the Federal Highway Administration to incentivize or reimburse the use of clean construction materials in transportation projects. EPA's label program will prioritize steel, glass, asphalt, and concrete.

EPA also issued several supporting documents to help implement the label program, including Product Category Rule (PCR) Criteria and documents outlining key remaining data gaps, a methodology for assessing life-cycle data quality, and descriptions of other federal data quality improvement activities.

EPA Finalizes Four Major Regulations

The U.S. Environmental Protection Agency on April 25, 2024, unleashed a barrage of four regulations targeting fossil fuel-based power generation, including:

- A final rule for existing coal-fueled and new natural gas-fueled power plants that would ensure all coal-fueled plants that plan to run in the long term and all new baseload gas-fueled plants control 90 percent of their carbon emissions.
- A final rule strengthening and updating the Mercury and Air Toxics Standards (MATS) for coal-fueled power plants, tightening the emissions standard for metals by 67 percent and finalizing a 70 percent reduction in the emissions standard for mercury from existing lignite-fueled sources.
- A final rule to reduce pollutants discharged through wastewater from coal-fueled power plants by more than 660 million pounds per year.
- A final rule that will require management of coal ash that is placed in "legacy sites" that were unregulated at the federal level until now, including at previously used disposal areas that may leak and contaminate groundwater.

For the most part, the final rules contained few changes from previously proposed drafts.

Utility groups pushed back on the carbon regulation's reliance on carbon capture as not ready for prime time. The National Mining Association criticized EPA for acting "with absolutely no analysis of the collective impact of these rules on the nation's alarmingly shaky grid reliability."

Attention quickly turned to the litigation likely to commence soon over the regulations. EPA officials expressed confidence in their legal position, while members of Congress prepared for potential legislative responses to the new regulations.

EPA Regulatory Agenda Updated

The U.S. Environmental Protection Agency updated its official schedule for pursuing coal ash rulemakings that remain open. In the agency's 2024 "Spring Unified Agenda," one key rulemaking was moved up from the long-term actions list and another was relegated to it—where it joins the issue of greatest importance to coal ash beneficial use.

Earlier this year, EPA finalized new regulations for "legacy" coal ash disposal units and updated its Effluent Limitation Guidelines for steam electric power plants. Accordingly, those actions were removed from the agenda.

Included within 103 regulatory actions now on EPA's active list is a single coal ash-related matter—a Congressionally mandated requirement to create a federal permit program for use in states that don't seek EPA approval of their own permit programs and in Indian Country. EPA indicated in 2021 that it would finalize the rule by January 2022. That schedule later slipped several times to October 2022, July 2023, October 2023, and then to the long-term actions list with a March 2026 expected completion date. The agency has now moved the rulemaking back to its active list and established October 2024 as an expected completion date for a Final Rule.

Moving in the opposite direction is EPA's effort to finalize "implementation of closure" actions for coal ash disposal. In its Spring 2021 agenda, EPA originally planned action on this matter by July 2021—a deadline that later slipped to September 2022, March 2023, August 2023, and then October 2024. The matter has now slipped to the agency's long-term actions list with a completion date "to be determined."

Remaining on the long-term actions list is EPA's effort to revise its definition of coal ash beneficial use and regulatory treatment of "piles" staged for beneficial use. EPA continues to state that the agency is reviewing information obtained from public comments responding to a 2021 Notice of Data Availability "to determine the appropriate next steps." EPA is under a court mandate to address this issue, but the court imposed no deadline for EPA to act. EPA continues to list "to be determined" as a potential completion date for a Final Rule.

The unified agenda does not provide insight on how the agency intends to continue moving forward on utility requests for extensions of "cease receipts" deadlines and for alternative liner demonstrations. Litigation over proposed denials of several utility requests under these provisions of EPA's 2015 coal ash disposal rule was dismissed by a federal court in June. EPA has not yet indicated how or when it intends to move forward on finalizing the outstanding proposed denials and acting on numerous additional applications that remain unaddressed.

The American Coal Ash Association has submitted comments on several of the EPA rulemakings listed here, as well as responses to several other agency requests for information. Copies of all ACAA comments are available on the Government Relations Committee tab of the ACAA members-only website.

Coal Ash Litigation Dismissed

The U.S. Court of Appeals for the District of Columbia Circuit on June 28, 2024, dismissed industry challenges to U.S. Environmental Protection Agency enforcement actions on coal ash.

Two lawsuits, each known as "Electric Energy Inc. (EEI), et al., v. EPA, et al.," were filed in 2022 after EPA began denying utility applications for extensions of "cease receipts" deadlines for coal ash disposal units under Part A of the agency's 2015 Coal Combustion Residuals rule. The Petitions for Review alleged that EPA unlawfully revised aspects of its regulation when it acted on the utility requests, claiming EPA's actions essentially changed the substance of the regulation without proper opportunities for public notice and comment.

"In these two related cases, the owners and operators of several coal-fired power plants challenge Environmental Protection Agency actions applying and enforcing regulations that govern the disposal of coal combustion residuals," the Court wrote in its decision. "Petitioners argue that the challenged agency actions amend existing legislative rules governing such disposal and that EPA was therefore required to promulgate those amendments according to the notice-and-comment procedures of the Administrative Procedure Act. Because the challenged documents straightforwardly apply existing regulations, they do not amount to the kind of agency action 'promulgating a[] regulation, or requirement' that we have jurisdiction to review under the Resource Conservation and Recovery Act. We accordingly dismiss the related petitions for lack of jurisdiction."

State CCR Permit Program Denied

The U.S. Environmental Protection Agency on May 23, 2024, issued its final decision to deny Alabama's application to run a federally approved state permit program to manage coal ash landfills and impoundments. The denial marks the first time EPA has rejected a state application for a coal ash disposal permit program after previously approving programs in Oklahoma, Georgia, and Texas. EPA is also under Congressional mandate to develop a federal permit program for use in states without approved programs, but development of that regulation has been repeatedly delayed and most recently was moved to the agency's long-term actions list with a new target completion date of March 2026. EPA's administrator said the agency would leave the door open for Alabama to submit a second "approvable application" in the future.

2024 American Coal Ash Association Membership Directory

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