Engineering and Environmental Specifications of State Agencies for Utilization and Disposal of Coal Combustion Products

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INTRODUCTION

The efforts on this project were made possible by funding from the National Energy Technology Laboratory Combustion Byproducts Recycling Consortium with industry support from the American Coal Ash Association (ACAA) and the Utility Solid Waste Activities Group.

The objectives of this paper are twofold. The first is to present a state-by-state comparison of U.S. Department of Transportation (DOT) specifications governing the use of coal combustion products. Because of lack of time and funding, most transportation engineers cannot properly research all of the current technologies of coal ash utilization. This compilation allows transportation and materials engineers to become familiar with other department practices and to identify areas where specifications need to be developed within their own transportation offices. Engineering practices are slow to change for many reasons. To facilitate changes, a systematic approach must be taken. The results from this effort will help familiarize DOT engineers and officials with coal ash use applications and will help the coal ash industry develop a plan to work with these departments and individuals in expanding their knowledge and familiarity while expanding coal ash markets.

The second objective is to establish a comparison of appropriate state agencies overlooking environmental regulations as they pertain to utilization and/or disposal. The impact of this technology will be in the form of supplying useful information to promote coal ash utilization and, when needed, establish useful guidelines for its disposal. Each state has its own specifications and environmental regulations. Often these two areas overlap in their guidelines, and the rules of one can either benefit or adversely affect the other. If an up-to-date, documented comparison between state agencies can be established, it can be used to help establish and promote a national consensus for coal ash utilization and/or disposal.

DEPARTMENT OF TRANSPORTATION SPECIFICATIONS

The DOT specifications and state environmental agency regulations will be presented separately. A survey letter was sent to all highway departmental offices in the United States and Canada in August 1992 to determine the differences between state and provincial DOT specifications for coal by-product utilization. Since that time, numerous changes have occurred in these departments so it was decided an update was needed. An extensive survey was begun in 2004 to obtain specifications from all state DOT offices. All information was obtained through Internet searches and personal contacts within respective departments. Specifications on the use of coal by-products in construction procedures were requested. As was the case in 1992, there were three main specification criteria:

1. Physical and chemical specifications for coal by-products

2. Applications which utilize coal by-products and their corresponding specifications

3. Quantities of by-products which may be allowed in each application

The first step was to evaluate existing specifications as they appeared on Internet Web sites. The most utilized Web site was http://fhwapap04.fhwa.dot.gov/nhswp/index.jsp, which is maintained by the U.S. Federal Highway Administration (FHWA). This site consists of a searchable library of highway specifications from across the country. This site also features discussion forums to enhance communication and interaction in the development and use of various types of construction specifications. The FHWA Web site is not necessarily complete with all specification updates so other DOT sites had to be utilized. Two of these other Internet sources of DOT specifications were http://www.transdata.com/dots.htm and http://www.fhwa.dot.gov/webstate.htm. These sites established links directly to DOT offices. These DOT Web sites were often a good source of establishing personal contacts as well as checking specification updates. A summary was made for each state as to its existing specifications for utilization of coal by-products.

After a state summary was completed, an e-mail copy was sent to an appropriate representative from that state. The e-mail message was designed to accomplish two objectives. The first objective was to determine if there were any current specification updates that were not reflected on the available Web sites. The second objective was to establish a personal contact, with an e-mail address, within each transportation office. Today many industries rely on using the Internet and, in some cases, an e-mail address is as important and useful as a telephone number. To date, Web sites have been evaluated for all 50 states, with established e-mail contacts from 45.

The information obtained is presented in a series of tables allowing a quick reference between states and comparison of their different specifications. This facilitates evaluation of similarities and experiences in coal ash utilization on a state-by-state basis. This information is intended to be used as a means of basic comparison and not to serve as a comprehensive design manual.

DISCUSSION

Though specifications and practices varied between states, several similarities were noted. The specifications used in all reported cases for fly ash were American Society of Testing and Materials (ASTM) C618 and American Association of State Highway and Transportation Officials (AASHTO) M295. The title for both specifications is “Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.” Under both classification systems, fly ash is defined as “a finely divided residue that results from the combustion of ground or powdered coal.” Likewise, pozzolans are defined as “siliceous or siliceous and aluminious materials which in themselves possess little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.” These materials are then divided into three classifications: Class N, Class F, and Class C. Class N materials are raw or calcined natural pozzolans which may or may not be processed by calcination to induce satisfactory properties.

Class F fly ash is normally produced from burning anthracite or bituminous coal and has pozzolanic properties. Class C fly ash is normally produced from lignite or subbituminous coal. This last class of fly ash, in addition to having pozzolanic properties, also has some cementitious properties. Excerpts from the two classification systems, ASTM C618 and AASHTO M295, are given in Tables 1 and 2, respectively. The specification from AASHTO M295 is based on a previous ASTM C618 specification from 1996. Since that time ASTM C618 has been updated to the more recent version portrayed in this report.

Transportation departments will often change their specification from the indicated ASTM C618 and AASHTO M295 to reflect regional practices and preferences. One example of this is the requirement for loss on ignition (LOI). The lowest maximum level of LOI allowed by either specification is 5%. However, many states specified LOI values to be much lower. States such as Delaware, New York, North Carolina, and Rhode Island, as well as the District of Columbia, indicated a maximum allowable LOI of 4%. Still others, such as Arizona, Hawaii, Indiana, Idaho, Illinois, Kentucky, Missouri, Minnesota, New Jersey, New Mexico, North Dakota, Oregon, Ohio, South Dakota, Utah, Washington, and Wisconsin, accepted even lower maximum LOI values.

A similar situation also existed in the case for maximum levels of moisture content and fineness in which state DOT specifications are more restrictive than ASTM C618 or AASHTO M295. According to these specifications, the maximum percent retainment allowed on the No. 325-mesh sieve is 34% and the maximum acceptable moisture content is 3.0%. Several states, such as Alaska, Indiana, New Mexico, Oregon, and South Dakota, were more restrictive in either one or both of these parameters.

Table 1. ASTM C618-03 Chemical and Physical Specifications

Chemical Requirements	Mineral Admixture Class N	F	C
Silicon Dioxide, Aluminum Oxide, Iron Oxide (SiO_2 + Al_2O_3 + Fe_2O_3), min., %	70	70	50
Sulfur Trioxide (SO_3), max., %	4	5	5
Moisture Content, max., %	3	3	3
LOI, max., %	10	6[A]	6
Physical Requirements	**N**	**F**	**C**
Fineness: Amount retained when wet-sieved on 45 μm (No. 325) sieve, max., %[B]	34	34	34
Strength Activity Index[C] with Portland Cement at			
7-day, min. % control	75[D]	75[D]	75[D]
28-day min. % control	75[D]	75[D]	75[D]
Water Requirement, max., % control	115	105	105
Soundness Autoclave Expansion or Contraction, max., %[E]	0.8	0.8	0.8

[A] The use of Class F pozzolan containing up to 12% LOI may be approved by the user if either acceptable performance records or laboratory test results are made available.
[B] Care should be taken to avoid the retaining of agglomeration of extremely fine material.
[C] The strength activity index with portland cement is not to be considered a measure of the compressive strength of concrete containing the fly ash or natural pozzolan. The mass of fly ash or natural pozzolan specified for the test to determine the strength activity index with portland cement is not considered to be the proportion recommended for the concrete to be used in the work. Strength activity index with portland cement is a measure of reactivity with a given cement and may vary as to the source of both the fly ash or natural pozzolan and the cement.
[D] Meeting the 7-day or 28-day strength activity index will indicate specification compliance.
[E] If the fly ash or natural pozzolan will constitute more than 20% by weight of the cementitious material in the project mix design, the test specimens for autoclave expansion shall contain that anticipated percentage.

Table 2. AASHTO M295-98 Chemical and Physical Specifications

Chemical Requirements	Mineral Admixture Class N	F	C
Silicon Dioxide, Aluminum Oxide, Iron Oxide (SiO_2 + Al_2O_3 + Fe_2O_3), min., %	70.0	70.0	50.0
Sulfur Trioxide (SO_3), max., %	4.0	5.0	5.0
Moisture Content, max., %	3.0	3.0	3.0
LOI, max., %	5.0	5.0	5.0
Available Alkalies, as Na_2O, max., %[A]	1.5	1.5	1.5
Physical Requirements	**N**	**F**	**C**
Fineness: Amount retained when wet-sieved on 45 μm (No. 325) sieve, max, %[B]	34	34	34
Strength Activity Index[C] with Portland Cement at:			
7-day, min. % control	75[D]	75[D]	75[D]
28-day min. % control	75[D]	75[D]	75[D]
Water Requirement, max., % control	115	105	105
Soundness Autoclave Expansion or Contraction, max., %[E]	0.8	0.8	0.8

[A] Applicable only when specifically required by the purchaser for mineral admixture to be used in concrete containing reactive aggregate and cement to meet a limitation on content of alkalies.
[B] Care should be taken to avoid the retaining of agglomeration of extremely fine material.
[C] The strength activity index with portland cement is not to be considered a measure of the compressive strength of concrete containing the mineral admixture. The strength activity index with portland cement is determined by an accelerated test and is intended to evaluate the contribution to be expected from the mineral admixture to the longer strength development of concrete. Strength activity index with portland cement is a measure of reactivity with a given cement and may vary as to the source of both the mineral admixture and the cement.
[D] Meeting the 7-day or 28-day strength activity index will indicate specification compliance.
[E] If the fly ash or natural pozzolan will constitute more than 20% by weight of the cementitious material in the project mix design, the test specimens for autoclave expansion shall contain that anticipated percentage.

Additionally, state specifications may undergo a series of alterations dependent on changes in national standards and field experiences. Other isolated differences in state specifications from national standards included maximum allowable autoclave expansion, maximum level of magnesium oxide (MgO), and a minimum calcium oxide (CaO) level. In Colorado, fly ash would only by accepted from a preapproved source, not at all an unusual DOT requirement, but preapproval required submission of a report from the supplier documenting the results of testing the fly ash from that source in accordance with the toxicity characteristic leaching procedure.

Fly ash use as a partial cement replacement in concrete was the most frequently indicated application. In most instances, 15% partial replacement of cement in a concrete mixture is allowed. The amount of fly ash used in place of the cement would either be added on a pound-for-pound basis or as additional weight. The most common practice was to replace 15% of the cement with 20% fly ash. This was a practice originally specified in FHWA publications and was commonly incorporated into state departments of transportation across the country. However, in the past several years many states have allowed for larger levels of replacement, depending on the applications. Other partial replacement levels were based on weight ratios varying from 1.0 to 1.35 portions of fly ash for every 1.0 portion of cement. In states which have access to both Class C and Class F fly ash, the percent of partial replacement and the amount of fly ash used as the replacement material would often be dependent on the fly ash classification. It was also commonly specified that the blending of different ash sources was prohibited.

In addition to concrete, numerous states have used fly ash as a mineral filler in asphaltic concrete and soil stabilization, with many more states beginning to use fly ash in flowable mortar applications. In the cases of fly ash for use in asphalt, the test procedure ASTM D242, “Mineral Filler for Bituminous Paving Mixtures,” was commonly cited. This specification assesses fly ash for retainment on the No. 30-, 50-, and 200-mesh sieves and for organic impurities and plasticity indexes.

In soil stabilization, ASTM C593, “Fly Ash and Other Pozzolans for Use with Lime,” is generally cited as a material specification. ASTM C593 provides evaluation criteria for fly ash by durability testing according to compressive and vacuum saturation strengths. In soil stabilization applications, it is the CaO contained in the fly ash that is being exploited for its potential engineering use. Thus there is usually a minimum level of CaO associated with fly ash being used in this application. There are several forms of what could be considered soil stabilization, such as cement-treated base, subgrade stabilization, subbase stabilization, and base course. States with some type of specification for soil stabilization include Arkansas, Illinois, Indiana, Mississippi, Nebraska, North Dakota, Oklahoma, Pennsylvania, Tennessee, Texas, Virginia, and Wisconsin as well as Washington, D.C., and the Federal Lands Highways.

Flowable mortar fill, also known as controlled low-strength materials (CLSM) and control density fill, is a low-strength flowable slurry for use as an economical fill or backfill material. It is generally placed by pouring from a commercial ready mix concrete truck.

The applications of CLSM mixtures include sewer trenches, utility trenches, bridge abutments, conduit trenches, retaining walls, foundation subbases, subfootings, floor slab bases, abandoned underground storage tanks and wells, and voids under pavement. Flowability can be measured by the standard slump cone method for concrete (ASTM C143) with measurements generally at 8 in. or higher. Another method of measuring flowability is ASTM C934, “Flow of Grout for Preplaced Aggregate Concrete Flow Cone Method.” CLSM mixtures are self-leveling and can be placed with minimal effort and no vibration or tamping. Long-term compressive strengths can vary from 50 to 1200 psi. Flowable CLSM mixtures are an economical alternative because of the savings of labor and time over placing and compacting soil or granular materials. This technology was once considered relatively new, and few state transportation departments have specifications for flowable mortar applications. However, several do have standing specifications for CLSM and flowable density fills which often specified the use of fly ash as one of the constituents.

Another material often cited for use as a cement supplement was ground granulated blast-furnace (GGBF) slag. At one time, slag was generally only used as a blasting grit, in skid or traction applications or as aggregate in asphaltic concrete. However, now many state transportation departments allow its use in the production of portland cement concrete. The replacement levels of cement with GGBF slag varied from 20% to 50%. It was also not uncommon to allow it to be blended with fly ash in concrete. The materials specification cited for GGBF slag was ASTM C989 or AASHTO M302, “Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.” There are three main definitions listed under this specification. Blast-furnace slag is the nonmetallic product that is developed in a molten condition simultaneously with iron in a blast furnace. Granulated blast-furnace slag is the glassy granular material formed when molten blast-furnace slag is rapidly chilled as by immersion in water. Slag is granulated blast-furnace slag that is ground to cement fineness. The two most common specified grades of GGBF slag were Grades 100 and 120.

Most states included specifications for the allowable use of blended hydraulic cements. The specifications for these were ASTM C595 and AASHTO M240. The descriptions and definitions of these cements varied considerably. A Type IS cement (portland blast-furnace slag cement) is an intimate blending of cement and granulated blast-furnace slag in which the slag constituent is between 25% and 70% of the mass of portland blast-furnace slag cement. A Type I(SM) cement (slag-modified portland cement) is a cement in which the slag constituent is less than 25% of the mass of the slag-modified portland cement.

A portland-pozzolan (Type IP) cement consisted of an intimate and uniform blend of portland or portland blast-furnace slag cement and fine pozzolan, in which the pozzolan constituent is between 15% and 40% of the mass of the portland-pozzolan cement. A Type I(PM) cement (pozzolan-modified portland cement) is a blend of portland cement, or portland blast-furnace slag cement and fine pozzolan, in which the pozzolan constituent is less than 15% of the mass of the portland-modified portland cement.

The use of silica fume was often grouped into the same category as fly ash and GGBF slag as a mineral admixture in portland cement concrete. The specifications for silica fume are AASHTO M307, "Microsilica for Use in Concrete and Mortar," and ASTM C1240, "Use of Silica Fume as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout." Generally, very small amounts of silica fume were specified for used in a concrete mix design. These specified amounts were usually from 3% to 10% of the total cementitious material.

Several states made references to not allowing the blending of two or more sources of fly ash and to only allowing the use of ash that had been evaluated by Cement and Concrete Reference Laboratories. In several state DOT offices, it is a customary practice to use cutoff dates for when fly ash is not to be used in concrete pavements. The cutoff dates are dependent on the region of the country but can generally begin in early fall and extend to late spring. Table 3 furnishes an abbreviated comparison of DOT specifications.

SURVEY OF STATE LAWS AND REGULATIONS

The objective of the remainder of this report is to present a survey of the state laws and regulations authorizing beneficial reuse of coal combustion by-products (CCBs). Extensive research for this project began in 2004. The laws and regulations of each state were reviewed to identify statutory or regulatory provisions authorizing the beneficial reuse of CCBs. Information was collected through Internet and Westlaw searches. Additionally, a survey letter was sent to all of the states requesting copies of any legal authority upon which the state relies to authorize beneficial reuse of CCBs. In many cases, personal contact was also made with the states. Based on the information obtained, a summary of the CCB laws and regulations in each state was prepared.

The information in these sections provides an overview of state solid waste laws and regulations governing reuse of CCBs. This information will be useful to persons familiar with "beneficial use" regulations for CCBs in their particular state and will assist in the exchange of regulatory guidance to enhance the use of CCBs. This information is not intended to identify landfill or similar disposal requirements.

The information presented in these sections was obtained from numerous sources through February 2005. Although these sections seek to accurately describe authorized state CCB reuses in the states, the reader is cautioned to seek appropriate technical, environmental, and legal advice with respect to any actions that may be undertaken concerning the management and use of CCBs in any state. This information does not constitute legal or technical advice. Further, this information is not intended to advise the reader regarding legal or regulatory requirements applicable to CCB reuse projects in any state and should not be relied upon for this purpose.

For consistency, this report utilizes the term CCBs. The term is intended to generically refer to fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) sludge, or fluidized-bed combustion (FBC) material. The reader must recognize that each state

Table 3. State Department of Transportation Specifications

State	Fly Ash (FA)	Fly Ash Use in Concrete	GGBF Slag	Silica Fume (SF)	Other Uses
Alabama	AASHTO M295	Class F: 20% Class C: 30%	AASHTO M302: Grades 100 and120 Concrete – 50% Temp < 45°F – 25%	AASHTO M307 Concrete: 10% or 25% FA + 10% SF	Blended cement: IP Mineral filler in asphalt
Alaska	AASHTO M295	Class C and F: 20% 1.25#C / 1#cement 1–1.25#F / 1#cement		AASHTO M307	
Arizona	ASTM C618	Class C and F 20% 1.2# FA / 1#cement			
Arkansas	AASHTO M295 Class C or F	Class C and F: 20%	AASHTO M302: Grades 100 and 120 Concrete – 25%		Blended cement: IP, PM, SM Flowable fill, cement-treated base course
California	ASTM C618 Class F	Class F: 15%–25%		ASTM C1240 Concrete: 7%–10% or 25% FA and 10% SF	Blended cement: IP, MS
Colorado	ASTM C618 Class F	Class F: 20%–30%	Bed course and slope protection	ASTM C1240	Blended cement: IP, MS, GU ASTM C595
Connecticut		Class C and F: 15%			CLSM
Delaware	AASHTO M295	Max. allowed: 20%			Blended cement: IP, I(PM), IS, I(SM) ASSHTO M240
Federal Lands Highways	AASHTO M295 Class C or F	Class F: 20% ratio 1.5/1 Class C: 25% ratio 1/1	AASHTO M302: Grades 100 and 120 Concrete – 50%	AASHTO M307 Concrete: 10%	Fly ash aggregate, soil and subgrade stabilization, mineral filler, grout, masonry mortar
Florida	ASTM C618 Class C or F	Regular concrete: 18%–22% Mass concrete: 18%–55%	ASTM C989, Reg. concrete: 25%–70% Mass concrete: 50%–55% Drilled shaft concrete: 58%–62%	ASTM C1240 Reinforced concrete: 7%–9%	Blended cement: IP, IS, MS Drilled shaft grout: 33%–37% fly ash, CLSM
Georgia		Max. allowed: 15% FA/cement ratio: 1.5/1	Max. allowed is 50% on high-early strength concrete		
Hawaii	ASTM C618	Max. allowed: 15%			Blended cement: IP ASTM C595
Idaho	AASHTO M295 Class F	Class F: 20%–25%			
Illinois	AASHTO M295 Class C or F	Class F: 15% ratio 1.5/1 Class C:20% ratio 1.2/1	Grades 100 and 120, max. allowed: 30%, Precast max. allowed: 25%		Subbase stabilization, CLSM, drilled shaft grout; FA: 15% ratio 1.5/1, GGBF slag: 25%
Indiana	ASTM C618 Class C or F	Class C and F: 20%–25%	ASTM C989: Grades 100 and 120	ASSHTO M307	Blended cement: ISA, IPA, IS, IP AASHTO M240
Iowa	AASHTO M295 Class C or F	Class C and F: 15%	ASTM C989: Grades 100 and 120 Max. allowed in concrete: 35%		Blended cement: IS, IP
Kansas		Class F: 20% Class C: 10%	Maximum allowed in concrete: 35%		Blended cement: IS, IP

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Table 3. State Department of Transportation Specifications (continued)

State	Fly Ash (FA)	Fly Ash Use in Concrete	GGBF Slag	Silica Fume (SF)	Other Uses
Kentucky	ASTM C618 Class C or F	FA: 25%–30% ratio 1.25/1, 20% FA and 30% GGBFS	Max. allowed in concrete: 50%	ASSHTO M307	Blended cement: IP, IPA ASTM C595, CLSM, grout
Louisiana	ASTM C618 Class C or F	General concrete: 20% Structural concrete: 15%	AASHTO M302: Grade 120 Max. allowed in concrete: 50%		Blended cement: IP, IS AASHTO M240
Maine	AASHTO M295 Class F	Class F: 30%	AASHTO M302: Grade 120 Max. allowed in concrete: 50%	Allowed but no specified rate	Blended cement: IP(MS) AASHTO M240
Maryland	AASHTO M295 Class C or F	Class F: 15%–25%	AASHTO M302: Grades 100 and 120 Max. allowed in concrete: 25%–50%	ASTM C1240 Concrete: 5%–7%	Blended cement: IPM AASHTO M240
Massachusetts	AASHTO M295 Class F	Class F: 15%–30% For ASR mitigation	AASHTO M302: Grades 100 and 120 For ASR mitigation: 25%–50%	AASHTO M307 ASR: 5%–7%	Control density fill
Michigan	ASTM C618 Class C or F	Class F: 15%–30% FA + GGBFS: 15% + 25%	ASTM C989: Grade 100 Max. allowed in concrete: 40%	ASTM C1240	Blended cement: IS, I(SM), IP, I(PM) ASTM C595, mineral filler
Minnesota	ASTM C618 (very modified) Class C or F	General concrete: 15% Full depth bridge deck concrete: 30%	AASHTO M302: Grades 100 and 120 Max. allowed in concrete: 35%	Occasionally 5% allowed in bridge decks	Blended cement: IS, IP, IPA AASHTO M240
Mississippi	AASHTO M295 Class C or F	Class C and F: 25%			Soil stabilization (12% fly ash + 3%–4% lime), grout
Missouri	AASHTO M295 Class C or F	Class F: 15% Class C: 25%	AASHTO M302: Grades 100 and 120 Max. allowed in concrete: 25%		Blended cement: IP, IS, IPM, I(SM), AASHTO M240
Montana	AASHTO M295 Class C or F	Class C and F: 20% FA/cement ratio: 1.2/1	Max. allowed in concrete: 20%	AASHTO M307 5% SF w/ 15% FA	Blended cement: IP AASHTO M240
Nebraska	ASTM C618 Class C or F	Class F: no specified rate			Blended cement: IP, ASTM C595, CLSM, soil stabilization (Class C only)
Nevada	ASTM C618 Class C, F, or N				Blended cement: IP, IP(MS) ASTM C595, crack sealant
New Hampshire	AASHTO M295 Class F	Variable mix designs with fly ash, GGBFS, and SF	AASHTO M302: Grade 120		
New Jersey	ASTM C618 Class C or F	Class C or F: 15%–25%	AASHTO M302: Grade 120 Max. allowed in concrete: 30%	Bridge deck overlays (7 ± 0.5%)	Blended cement: IS, IPM, ISM grout, mineral filler
New Mexico	ASTM C618 Class C or F	Class C or F: 20%	Allowed use in concrete: 25%–50%	Concrete: 5%–12%	Blended cement: ASTM C595, flowable fill
New York	ASTM C618 Class F	General concrete: 20% Precast concrete: 15% Reinforced concrete: 25%	AASHTO M302: Grade 100	AASHTO M307	Blended cement: IP AASHTO M240, CLSM

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Table 3. State Department of Transportation Specifications (continued)

State	Fly Ash (FA)	Fly Ash Use in Concrete	GGBF Slag	Silica Fume (SF)	Other Uses
North Carolina	ASTM C618 Class C or F	Pavement, precast, and prestressed: 20% at a ratio of 1.2#FA / 1#cement	AASHTO M302: Grade 100 Max. allowed in concrete: 50%	ASTM C1240 Concrete: 4%–8%	Blended cement: IS, IP – AASHTO M240
North Dakota	AASHTO M295 Class C or F	Max. allowed: 30%			Stabilized soil
Ohio	ASTM C618 Class C or F	Max. allowed: 15%	ASTM C989: Grade 100 Max. allowed in concrete: 30%	ASTM C1240	Blended cement: SM – ASTM C595, CLSM
Oklahoma	AASHTO M295 Class C or F	FA: 15%–20%, FA and other pozzolan: 28%, FA + GGBFS + SF: 50%	AASHTO M302: Grades 100 and 120 Max. allowed in concrete: 50%	ASTM C1240	Blended cement: M240 – ISM, IPM, IS, and IP, C1157: GU, MS, HS, MH and LH; grouts, CLSM
Oregon	AASHTO M295 Class C or F	Class C or F: 20%–35%	AASHTO M302	AASHTO M307	Blended cement: SM AASHTO M240
Pennsylvania	AASHTO M295 Class C or F	General: 15%, Variable mixes w/ASR concerns	ASTM C989 or AASHTO M302: Grades 100 and 120, Max. allowed in concrete: 25%–50%	AASHTO M307	FA w/lime – ASTM C593 Flowable fill with variable FA, bottom ash, and GGBFS
Rhode Island	AASHTO M295 Class C or F	Max. allowed: 15%	ASTM C989: Grades 100 and 120 Allowed in concrete	AASHTO M307 Concrete: 7%	Blended cement AASHTO M240
South Carolina	AASHTO M295 Class C or F	Variable mix designs with FA, GGBFS, and SF	ASTM C989: Grade 100	ASTM C1240	Blended cement: ISM AASHTO M240
South Dakota	AASHTO M295 Class C or F	Class C or F: 15%–20%			Blended cement: IP, AASHTO M240, grout, mineral filler
Tennessee	AASHTO M295 Class C or F	Class C: 25% Class F: 15% ratio 1.25/1	AASHTO M302; Grade 100s and 120 Max. allowed in concrete: 25%		Blended cement: AASHTO M240 – ISM, IP, soil–lime–FA base course – ASTM C593, CLSM
Texas		General concrete: 35% Reinforced concrete: 20%–35% Class F: 40%			Blended cement: IP, ASTM C595 Lime – FA treated base course, mineral filler
Utah	ASTM C618 AASHTO M295 Class F or N	Class F or N: 20%		ASTM C1240	Blended cement: IP, IPMS, HS – ASTM C595, grout, CLSM
Vermont	AASHTO M295 Class C, F, or N	Class C, F, or N: 20%	AASHTO M302: Grades 100 and 120 Max. allowed in concrete: 25%	Allowed at state DOT specification	Blended cement: IP, AASHTO M240
Virginia	ASTM C618 Class C or F	Class C or F: 30%	ASTM C989: Grades 100 and 120	AASHTO M307 Concrete: 10%	Blended cement: AASHTO M240 IP, IS. Lime stabilization – ASTM C593, mineral filler
Washington	AASHTO M295 Class C or F	Class F only: 25%	AASHTO M302, Grades 100 and 120		Blended cement: IP(MS), IP, IS AASHTO M240. CLSM

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Table 3. State Department of Transportation Specifications (continued)

State	Fly Ash (FA)	Fly Ash Use in Concrete	GGBF Slag	Silica Fume (SF)	Other Uses
West Virginia	ASTM C618 Class C or F	Class C or F: 15%–19%	AASHTO M302, Max. allowed in concrete: 30%–45%	AASHTO M307 Concrete: 8%	Blended cement: ASTM C595 – IP, IS. CLSM
Wisconsin	ASTM C618 Class C	General concrete: 30% Superstructure: 15%–25%, reinforced: 5%–25%	ASTM C989: Grades 100 and 120 Slip form: 50%, reinforced: 5%–25% superstructure: 20%–30%, other: 30%		Blended cement: ASTM C595 – IP, FA in stabilized subbase
Wyoming	ASTM C618 Class C or F	Class C: 15% Class F: 20%–25%			Blended cement: AASHTO M240 I(PM)
Washington, D.C.	AASHTO M295 Class C or F	Class C or F: 15%	ASTM C989: Grade 120 Max. allowed in concrete: 50%		Blended cement: AASHTO M240 IS, IP. soil–lime–FA: ASTM C593

has different approaches to classification of CCBs and that these respective classifications may limit or expand allowable uses of CCBs. For example, in Pennsylvania CCBs are referred to as "coal ash" which is defined to include fly ash, bottom ash, and boiler slag. Conversely, some states include within the definition of CCBs wastes which have been combusted with other materials, such as petroleum coke, tire-derived fuel, and wood. In some cases these distinctions are noted herein. However, the reader should not assume that use of the term CCB infers that all types of CCBs are included within the scope of a particular state's regulations.

FEDERAL REGULATION OF CCBS

The principal federal statute under which hazardous and solid wastes are regulated is the Resource Conservation and Recovery Act, 42 U.S.C. §6901–6991 (RCRA). RCRA establishes a comprehensive cradle-to-grave system for regulating hazardous wastes. Specifically, Subtitle C of RCRA and its implementing regulations impose requirements on the generation, transportation, storage, treatment, and disposal of hazardous wastes. To trigger these requirements, a material must be a "solid waste" and the solid waste must be "hazardous."

Subtitle D of RCRA pertains to State or Regional Solid Waste Plans. Wastes which are not considered hazardous under Subtitle C fall under Subtitle D and are subject to regulation by the states as solid waste. As originally drafted, RCRA did not specifically address whether CCBs fell under Subtitle C as a hazardous waste or Subtitle D as a solid waste.

In 1980, Congress enacted the Solid Waste Disposal Act amendments to RCRA. Under the amendments, certain wastes, including CCBs, were temporarily excluded from Subtitle C regulation. This regulatory exemption, 42 U.S.C. §6921(b)(3)(A)(i), is commonly referred to as the "Bevill Exemption." As a result, CCBs fell under Subtitle D and became subject to regulation under state law as solid waste.

As the Bevill Exemption was temporary, the amendments further directed that the U.S. Environmental Protection Agency (EPA) produce a report regarding CCBs and to pursue appropriate regulation, 42 U.S.C. §6982(n). In accord with this mandate, EPA issued its first report to Congress in 1988 titled *Waste from the Combustion of Coal Electric Utility Power Plants* (EPA/5-30-SW-88-002). This EPA report concluded that CCBs generally do not exhibit hazardous characteristics and that regulation of CCBs should remain under state Subtitle D authority.

Following litigation against EPA by the Bull Run Coalition because EPA failed to timely issue a regulatory determination as stated in its 1988 report to Congress, EPA entered into a consent decree with the Bull Run Coalition which included a time frame for EPA to issue a formal recommendation regarding regulation of CCBs. Pursuant to the consent decree, EPA issued a final regulatory determination applicable to fly ash, bottom ash, boiler slag, and FGD material which became effective September 2, 1993, 58 *Federal Register* 42, 466 (August 9, 1993). The rule states that regulation of CCBs generated by coal-fired electric utilities and independent power producers as hazardous waste is unwarranted and that the materials will remain exempt from regulation as a hazardous waste under RCRA.

EPA has narrowly interpreted this exemption. According to EPA, the exemption applies only to coal-fired electric utilities and independent power producers. It does not include CCBs generated at any other industrial activity (*In re: Wheland Foundry*, EAB, No. 93-2, December 22, 1993). Further, FBC wastes, low-volume wastes (boiler blowdown, coal pile runoff, cooling tower blowdown, demineralizer regenerant rinses, and metal and boiler cleaning wastes), and pyrites and comanaged wastes (referred to as remaining wastes) are not covered by the rule. EPA decided that more study was needed on these remaining wastes before an exemption determination could be made.

EPA was initially scheduled to complete a study of remaining wastes by September 30, 1998, and issue a final regulatory determination regarding these wastes by April 1, 1999, pursuant to the consent decree in the Bull Run Coalition litigation. Based on this obligation, EPA's study of FBC wastes, low-volume wastes, pyrites, and comanaged wastes were subsequently discussed in a March 31, 1999, Report to Congress. The report indicated that FBC wastes, low-volume wastes, and remaining wastes should continue to maintain their "Bevill Exemption" and that regulation under Subtitle C was not warranted.

Based on extensions of the consent decree mentioned above, EPA was to issue a final regulatory determination addressing FBC wastes, low-volume wastes and remaining wastes by April 10, 2000. In early March, EPA circulated a draft regulatory determination which indicated that, contrary to the 1999 Report to Congress, these wastes would be regulated under Subtitle C. EPA's stated basis for this shift in position was that remaining wastes did present environmental concerns, particularly concerns regarding groundwater leaching and the effects on drinking water standards, as well as effects associated with mercury exposure. The ACAA, as well as other shareholder groups, did not agree that regulation of CCBs as hazardous was warranted and met with EPA to discuss their concerns associated with the draft approach.

After much debate and discussion among EPA, industry, and environmental groups (as well as an extension of the consent decree), EPA issued its final regulatory determination April 25, 2000, which was published in the Federal Register on May 22, 2000 (65 *Federal Register 32213)*.

The final regulatory determination states that FBC wastes, comanaged wastes, as well as coal combustion wastes from non-utilities, petroleum coke combustion wastes, coburning of coal and fuel, and oil and natural gas combustion will not be regulated under Subtitle C and would continue to maintain their Bevill Exemption.

However, in determining if low-volume wastes are subject to Subtitle C regulation, EPA divided the low-volume wastes into two new categories: uniquely associated wastes and non-uniquely wastes. EPA took the position that when uniquely associated low-volume wastes are comanaged, those wastes would continue to be exempt from regulation under Subtitle C. However, if these wastes are managed independently and if they exhibit hazardous characteristics, they are subject to Subtitle C regulation. EPA defined these uniquely associated low-volume wastes to include coal pile runoff, coal mill rejected and waste coal, air heater and precipitation wastes, flow and yard drains and sumps, wastewater treatment sludge, and boiler fireside chemical cleaning waste.

EPA defined non-uniquely associated wastes as boiler blowdown, coal pile runoff, cooling tower blowdown, demineralizer regenerant rinses, metal and boiler cleaning wastes (which was the historical definition for all low volume wastes). Under EPA's final regulatory determination, when these non-uniquely associated wastes are comanaged or managed independently, they are not automatically exempt from regulation under Subtitle C, but must rather go through an RCRA hazardous waste determination.

The determination also indicated that EPA would be looking to the states to ensure proper regulation for certain CCB applications. In particular, EPA expressed the view that CCBs disposed in landfills or surface impoundments or used to fill surface or underground mines should be regulated by the states. Alternatively, EPA stated it would develop federal regulations of these applications under Subtitle D of RCRA. EPA indicated in the regulatory determination that in developing/reviewing regulations it would look at the extent to which CCBs caused actual or potential damage to human health and/or the environment, the environmental effects of filling mines with CCBs, the adequacy of existing regulations, and the effects of mercury exposure from these activities. EPA further indicated any federal regulations would be developed through notice and comment rule-making.

STATE REGULATION OF CCBS

As a result of the federal law developments described above, CCB reuse options are determined by state law. CCBs are generally exempt from hazardous waste regulations, and the states have elected to regulate these materials as solid, special, or industrial wastes. States that do not exempt CCBs from hazardous waste regulations require testing to determine hazardousness, and if shown to be non-hazardous, the CCBs are regulated as solid waste.

Most states currently do not have specific regulations addressing the use of CCBs, and requests for CCB uses are handled on a case-by-case basis or under generic state recycling laws or regulations. Many states have generic laws and regulations which authorize limited reuse and recycling of hazardous and/or solid wastes. These generic laws do not apply specifically to CCBs or any other materials. In general, under these regulations, materials are not considered solid wastes when they can be recycled by being:

- Used or reused as ingredients in an industrial process to make a product, provided the materials are not being reclaimed.

- Used or reused as effective substitutes for commercial products.

- Returned to the original process from which they are generated, without first being reclaimed. The materials must be returned as a substitute for raw materials feedstock, and the process must use raw materials as principal feedstocks.

The following materials remain regulated solid wastes, even if the recycling involves use, reuse, or return to the original process:

- Materials used in a manner constituting disposal or used to produce products that are applied to the land

- Materials burned for energy recovery, used to produce a fuel, or contained in fuels

- Materials accumulated speculatively

- Inherently wastelike materials

In addition, there is little consistency amongst the states regarding use of CCBs in mine applications. Some states have detailed regulations for reuse of CCBs in mine applications (some of which are discussed herein). Other states address this common use of CCBs by reference to fly ash and FGD material as materials which may be permitted as "discharges" to the mine upon approval by the state mining agency.

In general, the legal and technical requirements for mine applications are complex. For this reason, these regulations are not discussed in detail but are noted so further research can be done in the event the reader is interested in the potential application of these regulations to a proposed project. There may be significant changes in the regulations applicable to mine reuse applications. EPA has identified this as an area where greater regulation is warranted.

CONCLUSION

A number of states have adopted laws and regulations or issued policies and/or guidance specifically pertaining to CCB use. The CCB uses authorized within these states vary widely. Some states authorize liberal use of CCBs, while others authorize CCB use only in limited applications. In addition, the level of regulatory control and oversight varies significantly. CCB uses presenting the greatest concern to state regulators are those which involve land application such as use of CCBs in agricultural applications, structural fills, mine applications, and embankments. Some states consider these applications to be waste disposal and not reuse or recycling.

Finally, other states have elected to adopt "industrial solid waste beneficial use" rules, intended to authorize use of a variety of material such as coal ash, paper mill sludge, and foundry sand. These reuse rules with application to multiple materials may represent a growing trend.