Memorandum

TO: Rulemaking Docket

FROM: Keith Barnett, US EPA, Environmental Engineer

SUBJECT: Combustion in a Cement Kiln and Cement Kilns' Use of Tires as Fuel

DATE: April 25, 2011

A cement kiln that combusts any non-hazardous solid waste is subject to regulation as a Commercial or Industrial Solid Waste Incineration (CISWI) unit pursuant to section 129 (g) (1) of the Clean Air Act. In order for a cement kiln to be classified as a CISWI unit, it must have an input that is a non-hazardous solid waste, and the cement kiln must "combust" the solid waste. EPA has recently promulgated a definition of non-hazardous secondary materials which are solid wastes. See 76 FR 15456 (March 21, 2011).

This memorandum describes the Portland cement production process and discusses whether certain secondary materials used in that process are combusted in the kiln. This memorandum also addresses the question of whether tires burned by certain cement kilns in their performance testing would have been defined as solid wastes under the recently-promulgated definition of non-hazardous secondary materials that are solid wastes had that definition applied at the time of the burning.

Since combustion is not defined in the CAA, we use a common definition of combust which is "an act or instance of burning" or "a chemical process (as an oxidation) accompanied by the evolution of light and heat". [1]

Basic Kiln Process

In a cement kiln, there are two types of inputs, fuels and ingredients. Fuels provide the energy necessary to produce the heat required to raise the temperature of the ingredients to the level required for clinker formation. Ingredients provide the materials that make up the actual clinker mass. The ingredients are also called kiln feed or raw meal.

Figure 1 presents a schematic of a typical long wet or dry cement kiln. Ingredients are introduced into the back or cold end of the kiln at 300 to 500 ˚F (cold here being a relative term).[2] The materials gradually move down the kiln over a period of 60-90 minutes and increase in temperature until they reach the temperature required for clinker formation (about 2600 to 2700 ˚F). The ingredients undergo several different reactions as the temperature increases. It is important that the mix move slowly enough to allow each reaction to be completed at the

[1] Webster's Ninth New Colleg1ate Dictionary. Merriam-Webster Inc. 1990
[2] Environmental Progress (vol. 11, No. 1) February,1992, Petroleum and Petrochemical Waste Reuse in Cement Kilns, David Gossman

appropriate temperature. Because the initial reactions are endothermic (energy absorbing), it is difficult to heat the mix up to a higher temperature until a given reaction is complete.[3]

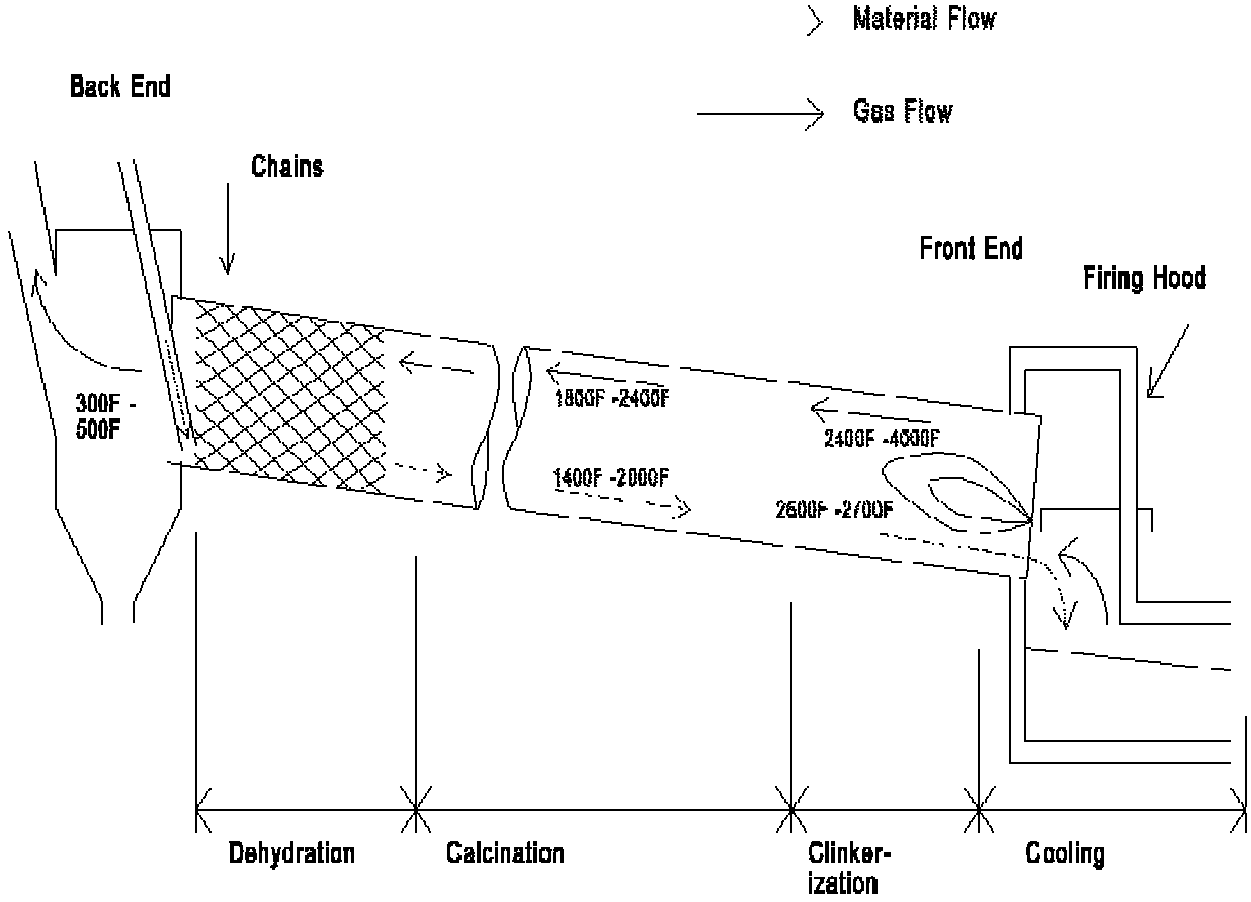


Figure 1. Schematic of a long cement kiln

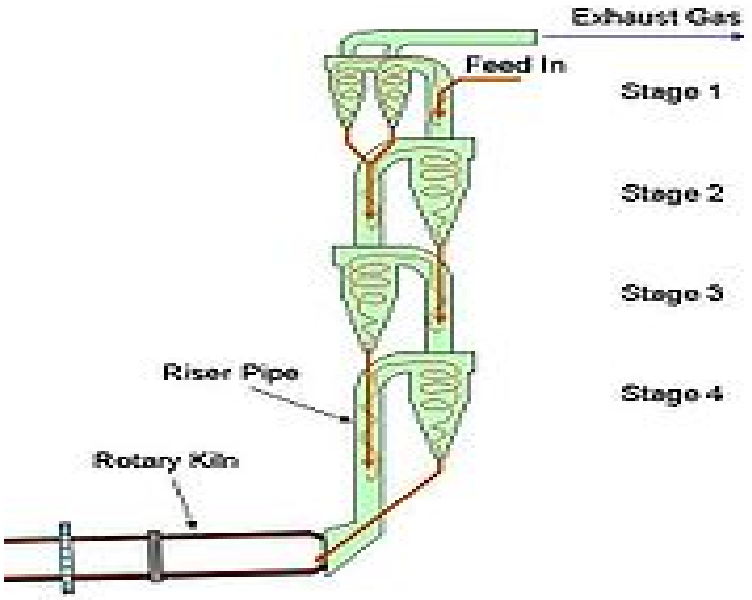
In contrast to ingredients, fuels are introduced into the hot sections of the kiln (either the front end or mid kiln) where gas temperatures are 1800 to 4000 ˚F. At these high temperatures the fuels immediately burn when introduced into the kiln. Fuels are never introduced into the cold end of the kiln. If they were, they would slowly heat resulting in creation of significant amounts of carbon monoxide emissions and a loss of fuel heating value.

The process in a preheater or preheat precalciner kiln is similar to a long kiln. Ingredients (feed) enter the top of the preheater tower, which is the equivalent of the cold end of a long kiln (*see further discussion below).*[3] The raw meal passes down the tower while hot gases rise up, gradually heating the raw meal. By the time the time the materials have reached the bottom of the preheater tower the ingredients have partially calcined.[3] A preheater tower is likely to have 4-6 stages.

[3] Northwestern University. The Science of Concrete. http://iti.northwestern.edu/cement/

Fuels enter a preheater kiln at the front end of the kiln and also may be introduced at the bottom of the preheater tower. In the case of the precalciner kiln, fuel is introduced into a separate vessel typically located between the last two stages of the preheater tower. However, as is the case with a long kiln, the fuels are introduced into high temperature zones where combustion of the fuels occurs.

Figure 2. Preheater or Preheater/Precalciner kiln



Combustion does not occur in the cold end of the cement kiln. As explained above, materials[4] placed in the cold end of the kiln are heated gradually until they reach the temperature where clinker formation takes place (as opposed to the hot zone of a cement kiln where higher temperatures are applied as quickly as possible, not gradually). This is not a chemical process marked by the evolution of light and heat. Rather, it is analogous to cooking as opposed to burning.

In a letter dated April 8, 2011, the Portland Cement Association (PCA) questioned whether the cold end of a preheater/precalciner kiln engages in combustion when ingredients are added at that point. The top of the preheater tower in a preheater/precalciner kiln functions identically to the cold end of a long kiln. Ingredients are gradually heated – cooked rather than burned. Again, this is not a chemical process marked by the evolution of light and heat. As such, the top of the preheater tower equates to the cold end of a long kiln and the ingredients are not combusted in those areas of the kiln.

[4] We note again that fuels are never placed in the cold end of cement kilns (including preheaters).

PCA's April 8 letter also raised a related question concerning ingredients added at different levels of the preheater tower, rather than the top of the tower. (See April 8 letter p. 3 asking whether ingredients placed in "preheater towers that use the heat produced by the kiln to preheat the ingredients as they move through the various stages of the tower" would be combusted.) We believe that until the material reaches a high temperature zone of the kiln, which is the zone where fuel is being added, combustion does not occur for the reasons just given: ingredients are being heated gradually through a controlled process For example, some long kilns feed tire fuel at a mid-kiln location, so combustion occurs at mid-kiln. However, the colder parts of the kiln represent areas where materials are still being gradually heated. In preheater/precalciner kilns, this would also apply to the various level of the preheater tower until the materials reached a point where fuel is being introduced, either into a precalciner or the feed shelf of the rotary part of the preheater kiln.

Ingredients processed in high temperature areas of the kiln

Cement kilns process many secondary materials as ingredients, and almost always do so by introducing these materials into the cold end of the cement kiln (where combustion of ingredients does not occur, as explained above). In its April 8 letter, PCA notes that ingredients are sometimes introduced into the hot (fuel) end of the kiln, and asks whether those materials are combusted within the meaning of CAA section 129 (g).

The high temperature regions of cement kilns can engage in combustion, as when fuels are burned. However, the secondary material ingredients used by cement kilns would not be combusted, as explained below.

Two types of materials are removed from the kiln exhaust gases, typically by the air pollution control devices for particulates, and returned to the process as ingredients. The first is incompletely calcined material that is recycled back into the kiln as a normal part of the clinker manufacturing process. The second is other fine-grained, solid material removed from the system to allow the clinker to meet specific quality standards or to maintain process stabilization. See PCA Letter of April 8, 2011, p. 3. These materials are often referred to as cement kiln dust.

The PCA letter noted that both of these materials may be reintroduced to the kilns in various places, depending on the kiln design and process. However, in this letter the PCA noted that in the case of preheater, preheater/precalciner, and long dry kilns that CKD is mixed with the raw meal feed and enter the cold section of the kiln. Therefore, these materials would not be considered to be combusted for the reason stated previously.

However, as noted in the April 8 PCA letter, in the case of wet kilns, cement kiln dust may be added to higher temperature zone regions (mid-kiln and the hot end). Cement kiln dust in this case mainly consists of a material that has previously been heated and even partially calcined. Therefore, this material would be expected to be inert from the standpoint of combustion, i.e., it would not oxidize producing heat and light. In fact, cement kiln dust injected in hot end of the kiln within or in close proximity to the flame has the effect of cooling the

flame.[5] This demonstrates the fact that these materials do not create heat and thus do not combust.

In its April 8 letter, PCA states that the only ingredients presently placed in kilns' combustion zones (occasionally) are the cement kiln dusts. However, PCA raises the possibility of other hypothetical ingredients being added to a cement kiln's combustion zone. It is not necessary to address hypothetical possibilities here. In addition, we believe the potential for placing non-inert ingredients into kiln combustion zones is unlikely for two reasons. First, the raw materials must be chemically homogeneous.[6] Since ingredients must be combined and ground together in the raw mill and thoroughly mixed, feeding separate ingredients into other areas of the kiln would mean less through mixing of the ingredients. In addition, for the reason discussed on page 3 (necessity to heat ingredients gradually), introducing raw materials into a hot section of the kiln would be expected to reduce kiln thermal efficiency. It is also worth noting that non-hazardous secondary materials used as an ingredient in a combustion unit are not solid wastes, 40 CFR section 241.3 (b), assuming the legitimacy criteria in section 241.3 (d) are satisfied.

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Tires Used as Fuel

As part of the development of the CISWI rule, we requested additional information on the tire-derived fuels used by all cement kilns in the proposed CISWI rule data base based on their historic practices. This included over 30 cement kilns that previously reported using some type of tire derived fuels and included all the larger cement companies.[7] Specifically, the ICR asked these questions regarding tires combusted during the emissions tests for the kilns: a) what is the source of the whole tires the kiln combusted; b) did they come from tire piles or landfills, or from an established tire program, defined in the ICR as "one which harvests tires from vehicles and businesses, and then manages the tires carefully so they are not thrown away between collection and eventual use as fuel, for example by use of a tracking system", and c) if the kiln received tires from sources other than an established program, did they undergo processing to produce a tire derived fuel? [8]

In general, virtually all of the respondents indicated that they had obtained all of the tires they burned from established tire programs (as defined in the ICR). However, the kilns acknowledged that they could not account for the source of every tire provided by these programs. PCA, in its April 8 letter likewise indicated that "[s]ome companies obtain tires from brokers and do not know the source of all tires" (April 8 Letter, n. 5). Some of the ICR

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[5] PCA R&D Serial No. 2728a, A Qualitative Examination of the Control of Major Gaseous Pollutants Generated in Portland Cement Kilns**.** Walter L. Greer and Garth J. Hawkins, Portland Cement Association , 2004

[6] See http://en.wikipedia.org/wiki/Portland_cement

[7] See CISWI ICR Follow Up Request for Information – (ICR No. 2286.01; OMB Control No. 2060-0616; EPA Form No. 5900-122). January 28, 2011.

[8] The ICR also asked if the kiln had been burning on-specification or off-specification used oil, and whether tires that had been physically landfilled were too damaged or otherwise contaminated to be suitable for burning by a cement kiln.

respondents further indicated that they knew that these established programs occasionally (for example, once a year, or several days a year) would obtain tires from sources other than commercial sources, tire dealerships and other standard collection points. Examples mentioned in the responses are the annual tire 'amnesty day' or other cleanup programs whereby established programs (or in one instance, the kiln itself) accepts tires from individuals.

It is EPA's position that ultimate users are not responsible for knowing the source of all tires obtained from an established tire collection program. The certification required by 40 CFR section 60. 2175 (w) requires a non-waste tire user to certify that tires were obtained from an established tire collection program, that the tires are not discarded and are handled as valuable commodities from the point of removal through arrival at the burning facility. EPA does not interpret this language as requiring knowledge of each individual tire as this is a practical impossibility. In certifying, users also should not assume that tires from established programs which participate in occasional cleanup day are discarded – both because there is no information that the tires from the cleanup efforts were discarded (and these programs are designed to prevent discarding) and whether the kiln received tires from the sporadic cleanup days in any case. Rather, EPA interprets the certification requirement to be satisfied if the user deals with an established tire collection program (as defined in Part 241) which program can provide the user with reasonable assurance that it manages tires carefully from point of collection to point of burning and which does not receive tires which have been abandoned in landfills or otherwise abandoned. Virtually all of the respondents to the ICR stated that they dealt with such established tire collection programs, and provided information reasonably supporting that conclusion (or otherwise provided sufficient information from which EPA determined that the tires came from established tire management programs). In those instances where the kilns indicated that some of the tires they received from an established tire program had been discarded or suspected that that was the case, EPA counted the kiln as a CISWI (had the solid waste definition applied at the time of the performance test) in this analysis.

The responses are summarized (by quotation or near literal paraphrase) in the following table:

Company	Plant Location	Type of Tire Fuel	Tire Sources and Processing
Ash Grove Cement	Inkom	Whole Tires	• Receives tires from 'four county landfills' serving as staging areas (areas where tires are collected for recycling rather than disposal) which landfills are 'designated to receive and store tires' by State of Idaho as part of the used tire management system (which system is 'distinct from the municipal solid waste management system')[9]

[9] Staging of tires at landfills –using the landfill as a collection point without disposing of the tires in the landfill (or otherwise) – is an acceptable means of avoiding their discard. The definition

			• Sufficient information to determine that tires come from an established program and that kiln would not have been a CISWI
Ash Grove Cement	Durkee, Oregon	Whole Tires	• Receives whole tires from seven sources, two are landfills which have areas designated as tire staging areas • Oregon regulations for used tires similar to Idaho • Sufficient information to determine that tires come from an established program and that kiln would not have been a CISWI
Ash Grove Cement	Midlothian	Whole Tires	• Receives tires from one privately owned and operated waste management facility. • Kiln has anecdotal information that supplier occasionally picks up tires from illegal dumpsites, though most (but not all) of these tires are unsuitable for Ash Grove and are shredded and sent elsewhere. • Would probably have been a CISWI
Ash Grove Cement	Leamington, Utah	Whole Tires	• Burns only Tire chips. No information on ultimate source of tires. • Per other responses (i.e. Holcim Devil's Slide), UT has a state licensed program which oversees safe collection and management of tires • Based on features of state law, tires come from an established tire collection program and kiln would not have been a CISWI

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of "established tire management programs" in section 241.2 allows landfills to be used as staging areas as part of collection programs. Programs with landfill staging of tires can be "a comprehensive collection system that ensures scrap tires are not discarded and are handled as valuable commodities … from the point of removal from the vehicle through arrival at the combustion facility." ." A system which utilizes staging areas to collect tires for re-distribution, even if that staging area happens to be located at a landfill, meets this definition if the tires are placed in the staging area on arrival and properly handled prior to delivery at the combustion facility. For example, in this instance, Ash Grove noted its understanding that "all counties (sic) landfills purchased van trailers for the sole purpose of accumulating tires as part of the state's used tire management system" and that Idaho state law provides that landfills can be used as storage collection points for used tires under the state's used tire management system.

Ash Grove Cement	Seattle	Whole Tires	• Receives tires from one privately owned and operated tire source. State of Washington regulates transport and storage of tires • Based on features of state law, tires come from an established tire collection program and kiln and kiln would not have been a CISWI
Buzzi	Oglesby	Whole Tires	• Vast majority of whole tire fuel supplied from brokers that obtained tires directly from the generators (tire stores, etc.) and meets definition of established tire program • Program regulated by State of Illinois • Would not have been a CISWI
Buzzi	Pryor, Oklahoma	Whole Tires	• Unable to determine , but does not presently burn TDF at all • Not a CISWI based on existence of OK rules for tire collection programs noted by other cement kilns (which assure safe management after collection and predominantly remove tires from vehicles)
Buzzi	Maryneal	Whole Tires	• Vast majority of whole tire fuel supplied from brokers that obtained tires directly from the generators (tire stores, etc.) 'To the best of our knowledge, this TDF was from an established management program administered under Texas Administrative Code Title 30, Part 1, Chapter 328, Subchapter F.' • Would not have been a CISWI
Cal Portland	Colton	Whole Tires	• Established tire management program run by county. The county's main tire source was not specified in the response but is likely tire shops, etc. • This county also collects tires from the public and from illegal tire piles a few times a year. These tires are sorted and some eventually are sent to the cement kiln. • Would probably have been a CISWI due to known use of discarded tires
Cemex	Demopolis	Whole	• Tires are sourced through tire brokers

		Tires	through an established tire management program • The ultimate source of the tires is not specified, but the tire must meet certain CEMEX specifications. The company cannot rule out the possibility that landfilled or disposed tires may be included • CEXEX does partner with local municipalities to provide an outlet for amnesty tire collections which are designed "to avoid illegal tire dumps" and consist of individuals bringing tires to a kiln and not being charged a disposal fee. • All CEMEX kilns use only whole tires • Would not have been CISWIs
Cemex	Brooksville - North	Whole Tires	
Cemex	Miami	Whole Tires and TDF	
Cemex	Brooksville-South	TDF	
Cemex	Clinchfield	TDF	
Cemex	Knoxville	Whole Tires	
Cemex	Blacones	TDF	
Essroc	Bessemer	Whole Tires	• Has always used an established tire management program, 'one which harvests tires from vehicles and businesses, and then manages the tires carefully so they are not thrown away between collection and eventual use as a fuel' • Would not have been a CISWI
Essroc	Frederick	Whole Tires	
Florida Rock	Newberry	Whole Tires	• Receives tires from a private company. Tires are collected directly from the source that removes the tire from the vehicle. • Would not have been a CISWI
Holcim	Midlothian	TDF	• Tire Chips obtained from the Ada OK facility with no other processing • OK has a tire cleanup program, and facility also accepts tires from businesses and tire stores; never from landfills • Would not have been a CISWI due to use of tire fuel (but is CISWI based on other secondary fuels).
Holcim	Morgan	TDF	• Receives tires from a private company under a State program. The tires are processed into tire chips at Ada facility • Holcim Ada does not accept landfill tires (see previous write-up for Midlothian)

			• Sufficient information provided to determine that obtains tire from an established program • Would not have been a CISWI due to use of tire fuel (but is CISWI based on other secondary fuels).
Holcim (This facility was not on the CISWI List)	Ada	Whole Tires	• Tires from businesses and tire stores and from Oklahoma clean-up program. • Chips tires on site for other facilities. • Holcim in general does not accept landfill tires • Would not have been a CISWI
Holcim (This facility was not on the CISWI List)	Hagerstown	Whole Tires	• Tires from businesses and tire stores. • Holcim in general does not accept landfill tires • Sufficient information provided to determine that obtains tire from an established program and would not have been a CISWI
Lafarge	Roberta	TDF	• Sources from tire manufacturer or a local retailer under and established tire management program • Would not have been a CISWI
Lafarge	Joppa	Whole Tires	• Tires from a variety of sources including tire manufacturers, tire retail outlets, tire collection forms, auto and racing organizations, and tire processers. • Well established tire management program approved by the State of South Carolina • On rare occasions the plant participates in community cleanup and/or state funded cleanup efforts. • Would not have been a CISWI
Lafarge	Tulsa	Whole Tires	• Tire brokers who process tires under established tire management programs. • A State program allows reimbursement if 5 percent of the tires come from tire piles, landfills, or community clean-up efforts. (No mention if Lafarge or their tire brokers participate) • Would not have been a CISWI, since it obtains tires from an established tire collection program and there is no

			indication discarded tires are burned by the kiln
Lafarge	Whitehall	Whole Tires	• Sources from tire dealers or automotive shops under an established tire management program • Would not have been a CISWI
Lafarge	Harleyville	Whole Tires	• Tires from a variety of sources including tire manufacturers, tire retail outlets, tire collection firms, auto and racing organizations, and tire processers. • Well established tire management program approved by the State of South Carolina • Would not have been a CISWI
Lafarge	Seattle	Whole Tires	• Tires obtained from retailers in an established tire management program under State regulation • Would not have been a CISWI
Lehigh Cement	Leeds	Whole Tires	• Use an established tire management program • All Lehigh plants use whole tires • Would not have been a CISWI
Lehigh Cement	Redding	Whole Tires	
Lehigh Cement	Evansville	Whole Tires	
Lehigh Cement	York	TDF	
Mitsubishi Cement	Lucerne Valley	Whole Tires	• Established tire management program but no absolute assurance that some tires could have been discarded • Would not have been a CISWI
Monarch Cement	Monarch	Whole Tires	• Established tire management program • Would not have been a CISWI
National Cement of CA	Encino	TDF	• Tire chips and tire fluff. Fluff is from a facility that produces crumb rubber products. • Ultimate tire source not specified. • Status not certain, but reasonable to assume not a CISWI because of California rules establishing tire management programs and due to producing TDF to specification

Conclusion

Based on this information presented above, we conclude that no cement kiln would have been classified as a CISWI unit based on the use of secondary materials as an ingredient had the solid waste definition in Part 241 been promulgated at the time of the testing or the time of promulgation of the final NESHAP. In addition, all cement kilns surveyed obtained tire fuels from an established tire collection program. With the exception of the facilities that either acknowledged accepting tires that had been discarded or provided information from which some acceptance can reliably be inferred, the use of tire derived fuel by itself would not have resulted in a cement kiln being defined as a CISWI unit.