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Idaho National Engineering Laboratory

INTEC (Formerly ICPP) Ash Reutilization Study

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LOCKHEED MARTIN

DISCLAIMER

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EXECUTIVE SUMMARY

Since 1984, the Coal-Fired Steam Generation Facility (CFSGF) at the Idaho Nuclear Technology and Engineering Center (INTEC, formerly Idaho Chemical Processing Plant) has been generating about 1,000 tons of fly ash per year at the Idaho National Engineering and Environmental Laboratory (INEEL). This ash is hydrated and placed in an ash bury pit near the coal-fired plant. The existing ash bury pit will be full in less than 1 year (i.e., during FY 1999) at its present rate of use. A conceptual design to build a new ash bury pit was completed, and the new pit is estimated to cost $1.7 million. This report evaluates alternatives for reusing INTEC ash that would eliminate this waste stream and save the $1.7 million required to build a new pit.

Physical and chemical testing, based on standards of the American Society for Testing and Materials (ASTM), have been performed on ash from the existing pit and from different steps within the facility's processes. The test results have been evaluated, compared to commercial ash, and are discussed as they relate to reutilization alternatives.

This study recommends that the ash and the hydrated ash bury pit material be used in flowable fill concrete for Deactivation and Demolition (D&D) work at the INEEL. A number of facilities are presently scheduled to be demolished, and their basements, cells, or underground vessels are to be filled with flowable fill. The present plan calls for commercial fly ash to be added to cement to create this fill. The ash can be taken directly from the plant's silo or excavated from the pit, crushed, and mixed for use as the flowable fill ingredient.

This use as flowable fill would eliminate a waste stream at the INEEL, generate a cost savings of $1.7 million by eliminating the need for a new ash bury pit, and reuse the waste ash on projects that would otherwise require the purchase of additional materials. There would be implementation costs associated with this reutilization, but there are also cost savings as less commercial grade ash would need to be purchased for the D&D work at the INEEL. The three potential projects listed in this report plan on using over $500,000 of commercial grade fly ash. Some or all of this ash can be replaced by using our existing waste ash.

Any alternative chosen would require a commitment from the INEEL to use the ash. As this report demonstrates, several viable alternatives exist. Additional testing would be required to determine the specific technique needed to use the ash.

A major consideration and one of the drivers for this report is the fact that the existing ash bury pit will be filled to capacity within 1 year (during FY 1999). If an ash reutilization alternative is not selected or if excavating ash from the pit has not begun in time, an alternative disposal location will be required. Extending or adding onto the existing pit would not allow as great a cost savings, and would have to be built quickly. A preferred alternative would be to use one of the existing percolation ponds that are on the south end of INTEC. The ponds are no longer in use, are close to the coal-fired plant, have existing truck accesses that could be used, and are large enough for years of use. If the ponds are used for an interim ash disposal location, the ash could be excavated later for reuse of the ash. The percolation ponds could be lined, if required, so all ash could be removed at a later time.

Per the National Environmental Policy Act (NEPA) interpretation (Appendix B), any reuse of the ash will require a new Environmental Assessment (EA). A new EA would cost in the range of $60,000 to $80,000 and take 8 to 10 months to accomplish.

The second most viable option would be to use the ash for landfill day cover. This alternative uses an ash mixture to replace the 6-in.-thick layer of earth normally used in landfills for day cover. This alternative minimizes the volume of earth or cover material placed in the landfill, lengthening the life of the landfill while minimizing the need for large earth-moving equipment to spread soil day cover. Other viable alternatives discussed in this report include the following:

- Dust Control; hydrated ash can be spread on dirt roads or construction areas to cheaply minimize the amount of dust caused by winds or by traffic.

- Road Base; ash could be used in the base fill of new roads or hydrated ash could be placed in road fill to minimize moisture migration.
- Sewage Treatment; ash could be used in the sewage treatment process as its composition lends itself well to increasing the pH of sewage, it absorbs water, and would assist in creating a sludge, all of which are desirable in the treatment of sewage.

Any of the viable alternatives discussed in this report will need further research and testing to determine the exact mixture requirements needed for the reuse option selected. Candidate projects or uses at the INEEL, once selected, will need to develop and implement a strategy for testing and using the ash. To save the $1.7 million required to build a new pit, the candidate projects or uses for the ash will need to follow a schedule that will negate the need for a new pit. A new ash bury pit would need to be in use in FY 1999 or an alternative temporary dumping site would need to be selected.

The new pit construction cycle is 11 months (3 months for design and review, 2 months for bid, and a 6 month construction period). The flowable fill alternative would take 5 months from start to putting ash into reuse (3 months for design and review and 2 months for bid). The 5-month cycle assumes ash could be used as soon as the bid is awarded. The day cover alternative would take 7 months to implement (3 months for design and review, 2 months for bid, and 2 months for construction).

Based on this study, Infrastructure Management at Lockheed Martin Idaho Technologies Company will need to determine whether a new disposal pit is constructed, an alternative short-term disposal location is used, or if modifications to the facility or the existing ash pit are required to reuse the ash.

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INTEC (Formerly ICPP) Ash Reutilization Study

1. PURPOSE

The purpose of this report is to evaluate alternative uses for the ash produced by the Coal Fired Steam Generating Facility (CFSGF) and the existing ash in the ash bury pit, both located at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly Idaho Chemical Processing Plant (ICPP) within the Idaho National Engineering and Environmental Laboratory (INEEL). After the technical evaluation, this report recommends alternatives for the reuse of the CFSGF waste streams. Based on this study, Infrastructure Management at Lockheed Martin Idaho Technologies Company (LMITCO) will need to determine whether a new disposal pit is constructed, an alternative short-term disposal location is used, or which ash reutilization alternative is selected.

2. HISTORY OF FLY ASH MANAGEMENT

Since June 1984, the INTEC has been producing coal fly ash and spent bed material from its two Foster Wheeler atmospheric fluidized bed combustion (AFBC) boilers located at CPP-687. The ash removal system for this facility handles the waste material collected in the spent bed, economizer, and bag house hoppers. The ash is transported to and deposited in a 30-hour-capacity dry storage silo. Presently, ash is unloaded dry from the silo into a concrete truck that is partially filled with water. During transport to the ash bury pit, the ash and water are thoroughly mixed. At the ash bury pit, the concrete truck unloads the ash-water mixture, which has the consistency of very thick slurry. Within a few days, the water in the slurry evaporates, leaving a solid dustless mass.

The original ash bury pit had a capacity of about 70,000 yd^3 and in 1991, the pit was increased in size for a total volume of about 120,000 yd^3. This pit is currently approaching its maximum capacity. Construction of a new ash bury pit is being considered for an FY 1999 project in order to be ready for use by the time the existing pit is full. This construction project has prompted this analysis of alternative uses for the ash produced at CPP-687.

The American Coal Ash Association reports that in 1996, U.S. utilities generated nearly 102 million tons of coal combustion byproducts (ash, boiler slag and scrubber residue). Historically, these combustion byproducts ("ash") have been treated as a waste product and disposed of by placing in landfills. With increased environmental awareness and recognizing that the ash represents, in many cases, a usable product, increased emphasis has been placed on reusing the ash. Today, approximately 25% of the ash generated is used as commercial grade fly ash in concrete, grout, etc.

In addition to the commercial grade ash, about 11.5 million tons of AFBC ash is generated by nonutilities like the CFSGF at INTEC. Of this total, approximately 8.3 million tons are generated by plants from waste coal fuels. The majority of this waste coal-fired plant ash is used in mine reclamation projects in Pennsylvania and West Virginia. For the balance of 3.2 million tons, roughly 600,000 tons is being used as commercial product. The reduced use of AFBC residue as a commercial product, when compared to traditional coal combustion residue, results from unfamiliarity with the product due to the short time the material has been available in significant quantities.

Because of the wide range of fuel that can be used in an AFBC system, as well as the interaction of the variables affecting sulfur capture in the fluidized bed combustor, AFBC ash characteristics can vary widely. AFBC ash also incorporates the characteristics of any sorbents or other additives present in the fuel feed or bed make-up system. Add to this the variability of local environmental regulations, plant geographic location, and other factors. As a result, no uniform solution has emerged for management of these ashes. It is necessary to tailor the ash utilization program to each plant and geographic area.

Engineering data is not widely collected and distributed on the characteristics of AFBC ash. Coupled with this is the inconsistent quality of the material from plant to plant due to fuels and sorbents, as well as operating conditions, making generalizations difficult. For each plant and new application, several representative samples of the AFBC ash need to be collected and analyzed to predict the range of characteristics to be encountered before the ash can be used in alternative projects.

3. ALTERNATIVES

The following sections describe potential uses of INTEC incinerator ash, the volumes of ash that can be used, an implementation strategy, and the costs of implementation. Points of contact for this project are listed in Appendix A.

3.1 Landfill Day Cover

3.1.1 Description

In municipal solid waste landfills, AFBC ash can replace the 6-in. layer of dirt that is currently used for the daily cover. The ash can be preconditioned with water and spread and compacted, or mixed with other available material to provide a cover that will prevent wind blowing the refuse, varmint intrusion and still maintain an effective fire barrier. New technology is also available to combine AFBC ash, fiber, and other materials in a mixture that can be sprayed on as a thin (1/4- to 1/2-in. thick) self-hardening shell, thus saving disposal space in the landfill. Other uses in landfills include mixing the ash material with sludges to provide a material that is more stable and easier to handle.

3.1.2 Volumes of Ash that Can Be Used

To estimate the amount of day cover material that is used at a typical landfill, several landfill managers/operators were contacted. For larger landfills, the area that requires covering every day can be as much as 40 × 100 ft, or 4,000 ft^2. For smaller landfills or low volume days, the area that requires covering can be as little as 20 × 80 ft, or 1,600 ft^2. For the purpose of this report, an area of 3,000 ft^2/day will be used. Based on this area, the volume of ash that can be used per landfill per day is 6,250 lbm/day:

$$V_{ash} = (0.5\,in.)(\frac{1\,ft}{12\,in.})(3{,}000\,ft^2)$$

$$V_{ash} = 125\,ft^3$$

$$m_{ash} = (125\,ft^3)(50\frac{lbm}{ft^3})$$

$$m_{ash} = 6{,}250\ lbm/day$$

The volume of ash indicated above is for an average day cover and does not include the water or other admixtures that may reduce this volume.

Landfill Service Corporation provides equipment and material that mix and spray this type of material. The mixing/spraying equipment can be leased and a patented fiber reinforcement admixture can be purchased. The closest system of this type is used at the Salt Lake County landfill.

Several landfills were asked whether they would be interested in using such a day cover. Table 1 summarizes the responses:

Table 1. Landfill's response concerning their willingness to use fly ash slurry as a day cover.

Landfill	Response	Comments
INEEL	No	Lots of space
Bonneville Co.	NA	No response
Madison Co.	No	Ships their waste to Jefferson Co.
Jefferson Co.[a]	No	Lots of space and dirt is cheap
Bannock Co.	Maybe	Actively looking at alternatives, space is a premium. Would be interested in following up on this. Dirt is still cheap and they have equipment to move it around.
Bingham Co.	NA	No response

a. Jefferson County landfill potentially would take the INEEL waste ash if delivered to their landfill at a cost of $100/cubic yard in dry form. If the ash were hydrated they would take it for considerably less. Trucking costs are not included.

3.1.3 Implementation

To change the existing landfill day covers from soil to hydrated ash, the proposed spray-on day cover technology's effectiveness would have to be proven to the operators. The current mode of applying a 6-in. layer of dirt at the end of the day can be done quickly and easily with existing equipment. New mixers and spraying equipment would be needed to switch to a different day cover system. This new equipment would require extra cleaning and maintenance that may discourage implementation of the new process.

For landfill day covers, the intent is to provide a material that sets up relatively quickly and hardens to a density that prevents blowing of the material. The ash that has been hydrated and delivered to the ash bury pit would require considerable admixtures to get a material suitable for day cover use.

Dry, nonhydrated ash can be obtained from CPP-687 by two methods. First, from the existing ash silo that contains a stratified mixture of spent bed material, economizer ash, and bag house ash. Second, a second ash silo can be installed so that the spent bed material can be collected separately from the economizer and bag house ash.

Further analysis would need to be performed on the existing ash silo mixture to see if the fluctuations in ash constituents can be accepted for the day cover mix design. The first method for obtaining ash could be used if the fluctuations in ash constituents can be overcome; no changes to the existing silo would be needed.

It is most likely that a consistent source of ash will be required. This means that the second method for obtaining the ash would need to be implemented. A second ash silo and associated vacuum system would need to be installed to separate the ash from the spent bed material.

Regardless of the source of the material, equipment will be required to blend the ash for use as a spray-on landfill day cover. The equipment to mix and spray the material can be leased from Landfill Service Corporation. Depending on the type of product that is needed, the ash mixer/hydrator identified in the conceptual design may be able to be used.

For this application, only the dry ash from CPP-687 could be considered as a potential source of material and no ash from the bury pit would be used. Landfill day cover is the second most viable alternative use option. The day cover alternative would take 7 months to implement (3 months for design and review, 2 months for bid, and 2 months for construction.)

3.1.4 Costs

The following costs are estimated values for individual scopes of work. The complete cost estimate is provided in Appendix G. The estimates include costs for construction, engineering, management, and overhead adders. For each alternative, the applicable portions of the cost estimate were used to provide the total estimated cost of implementation as shown in Table 2.

Table 2. Cost breakdown for Landfill Day Cover alternative.

Scope of Work Required to Implement	Estimated Cost
Ash Silo Collection and Separation System	$1,346,334
Transportation of 1,000 tons	$ 20,800
Mixing/Spraying Equipment	$ 91,361
Total:	$1,458,495

This cost estimate assumes that a new ash collection silo will be installed and the dry ash will be transported to the landfill before mixing and spraying.

3.2 Concrete Admixture

3.2.1 Structural Concrete

Fly ash used in structural grade concrete per American Society of Testing and Materials (ASTM) C618 falls into one of three categories of concrete: Class N pozzolan concrete, Class F, or Class C. Table 6 compares the requirements for these three classes with ash sample averages from the ash pit and the coal-fired facility.

None of the INTEC ash samples meet the requirements for structural grade concrete fly ash. The total SiO_2, Al_2O_3, and Fe_2O_3 must be greater than 50% by weight for Class C and greater than 70% by weight for Classes N or F. Also the Loss on Ignition of the ash samples is greater than the 6–10% allowable. The amount of lime (calcium oxide) present in the samples is too large to allow the total SiO_2, Al_2O_3, and Fe_2O_3 to meet these requirements. The amount of carbon in the samples is relatively low and so the high lime content in the samples also probably explains the high Loss on Ignition.

To be able to use the fly ash, the lime content would need to be reduced. A process change in the facility may be possible to reduce future ash lime content, but the existing ash would have to have some of its lime removed to be usable for these classes of concrete. If a lime removal process were found and its cost effectiveness verified, it would be possible to make this option viable.

Potential problem areas were identified when discussing this alternative with a local commercial concrete company. The company was not in a position to handle a new material that did not meet the ASTM standards. The ash would have to be segregated from other material and modified before use, all of which presents the company with higher operating costs.

Based on these considerations, this alternative for reuse is not viable at this time.

3.2.2 Nonstructural Concrete

Nonstructural concrete uses for fly ash include concrete blocks, decorative landscape blocks, and mortar/grout. The ash from the facility and the existing pit could be used in concrete mixture for non-structural purposes. Concrete masonry block is specified under ASTM C90, mortar under ASTM C270, and grout under ASTM C476.

If a commercial manufacturer in the area was interested in the ash, further testing would need to be performed to verify the viability of the specific application. It may not prove to be cost effective to transport the ash to a manufacturer. If a project at the INEEL was identified that needed block, grout, or mortar, the use of the ash in a product would also need to be reviewed and tested. If the product could be mixed at the INEEL, it may prove to be cost-effective to use the ash.

Based on similar problems with the use of ash in structural concrete, and the fact that this alternative would provided intermittent and/or limited use, we find this alternative not viable.

3.3 Flowable Fill

3.3.1 Description

Flowable fill is considered "Controlled Low Strength Material" (CLSM) by the American Concrete Institute (ACI Committee 229). With some properties of concrete, flowable fill has a higher slump, lower compressive strength, and is easily placed without vibration or tamping. Due to its small, spherical particles, fly ash creates a ball bearing effect that improves the flow of concrete by reducing friction. Reduced friction makes it easier to pump the concrete mixture and for the mixture to fill small areas without needing vibration. It is normally delivered and placed by ready mix trucks for ease of placement. Cement mixed with fly ash are the normal ingredients in flowable fill. The ash reduces the fill cost and adds to the mixture's required characteristics. Flowable fill can be used for backfill of utility trenches or pile excavations. It can be used for structural fill of foundation subbase or areas of over-excavation. It can also be used for filling abandoned basements, cells, or vessels.

3.3.2 Volumes of Ash That Can Be Used

There are a number of D&D projects scheduled at INTEC and other areas at the INEEL that plan to use flowable fill to fill basements, cells, and vessels that are to be left in place. The planned use of flowable fill contains commercial grade fly ash. This ash can be entirely or partially replaced with ash from the coal-fired facility and/or from the existing fly ash pit. Table 3 lists candidate projects at INTEC that plan to use flowable fill concrete for D&D work, and the quantity of ash required.

Table 3. Potential users of flowable fill.

D&D Project Title	Yd^3 of Fill	Fly Ash Required	Scheduled Start Date
CPP 633 WCF RCRA Closure	4,000	1,280 tons	FY 1998
CPP 603 Basin Deactivation	7,300	2,340 tons	FY 2000
CPP 601, 627, 640 Fuel Reprocessing Complex Deactivation	26,000	8,320 tons	FY 1999
Totals Required	37,300	11,940 tons	

The estimated cost for commercial grade fly ash is about $45 per ton. Replacing the commercial-grade ash with INTEC ash for all three projects would result in a potential cost savings of about $537,300.

The quantities of existing ash in the pit and the ash that is produced each year at the coal-fired generating facility total more than the 11,940 tons listed above as total required. Ash from the facility and from the pit could be salvaged and used for this and other D&D work scheduled at INTEC and elsewhere on the INEEL.

3.3.3 Implementation

To use the ash from the existing bury pit, an additional roadway to the excavation site in the pit would need to be built. This additional roadway would allow excavation in the pit while the process of dumping ash into the pit could continue. Excavated ash would be taken to a grinder at an lay-down location adjacent to the pit. Ash would be run through the grinder and transported via truck to the batch plant in or near INTEC. The batch plant would be set up by the subcontractor doing the D&D work in one or more of the facilities at INTEC.

If ash were to be used directly from the plant, a new mixer would need to be installed at the existing silo. Ash would then be placed into a truck from the mixer on the silo. Ash would then be transported via the truck to the batch plant in or near INTEC. Ash used in flowable fill is the most viable option and will be the primary recommendation of this study. The flowable fill alternative would take 5 months from start to putting ash into reuse (3 months for design and review and 2 months for bid). The 5-month cycle assumes ash could be used as soon as the bid is awarded.

3.3.4 Costs

The following costs are estimated values for individual scopes of work. The complete cost estimate is provided in Appendix G. The estimates include costs for construction, engineering, management, and overhead adders. For each alternative, the applicable portions of the cost estimate were used to provide the total estimated cost of implementation as shown in Table 4.

This cost estimate assumes that the hydrated ash bury pit material will be used for the flowable fill. If dry ash from the silos is selected, a similar cost estimate can be generated by use of the applicable section of the cost estimate provided.

Table 4. Cost breakdown for Flowable Fill alternative.

Scope of Work Required to Implement	Estimated Cost
Additional roadway	$123,816
Excavation of bury pit at 1,000 tons	$369,565
Mixer	$170,000
Transportation of 1,000 tons	$ 20,800
Total:	$684,181

Note that the costs of the additional roadway and the new mixer are one time costs. Excavation and transportation are unit costs based on 1,000 tons. After the initial excavation of 1,000 tons, additional projects selected will have a cost of approximately $390,365 per 1,000 tons of ash excavated.

3.4 Soil Stabilization

3.4.1 Dust Control

3.4.1.1 Description. The fly ash, when hydrated and dumped into the bury pit to air dry, acquires a hard, crusty, dust-free consistency. The ash mixed with water could be spread over areas of construction or on dirt roadways for dust control. The hydrated ash consistency can vary in thickness from something similar to concrete to something thin enough to spray from a hose or watering truck. The amount of water mixed with the ash could be adjusted to allow for pouring or spraying onto the area requiring dust control. For dust control, the hydrated ash from the bury pit could be used or hydrated ash could be used directly from the truck that dumps the ash into the pit. When allowed to air dry in place, the crusty surface that the ash leaves would significantly help minimize dust that is normally blown around or is stirred up by traffic.

3.4.1.2 Volumes of Ash that Can Be Used. Construction areas throughout the INEEL that have dust problems could use the ash and leave it in place after construction, as it would be an acceptable material in backfill around foundations, for example. The quantity of ash that could be used is limited only by the number of dust control applications that can be identified.

3.4.1.3 Implementation. To use the ash from the existing bury pit, an additional roadway to the excavation site in the pit would need to be built. This additional roadway would allow excavation in the pit while the process of dumping ash into the pit could continue. Excavated ash would be taken to a grinder at a lay-down location adjacent to the pit. Ash would be run through the grinder and transported via truck to the construction area or dirt road requiring dust control.

If ash were to be used directly from the plant, the existing process of adding dry ash to a concrete truck which contains water could be used. The hydrated material would then be poured onto the ground in the desired location and allowed to set-up to provide the dust-free surface.

Ash used for dust control is a viable option, but is not considered one of the primary options in this report. The dust control alternative would take 5 months from start to putting ash into reuse (3 months for design and review and 2 months for bid). The 5-month cycle assumes ash could be used as soon as the bid is awarded.

3.4.1.4 Costs. To implement this alternative, the existing equipment can be used. Therefore, the implementation costs associated with this alternative are minimal. The only additional costs are associated with transporting the material to the location requiring dust control.

3.4.2 Road Base

3.4.2.1 Description. The hydrated ash would be an acceptable material for the base of new roadways. As a portion of a road base, the ash would be an effective and cheap fill that could use waste ash. Placed wet, the ash would minimize dust during the road's construction. Ash mixed with water could also be placed in new roads to minimize moisture migration. A layer of hydrated ash placed on the road base prior to placing the asphalt concrete would cause a moisture seal that would minimize water migrating through the base to the asphalt. Keeping moisture away from the underside of the asphalt is a major consideration during the design of a road. Minimizing moisture under the asphalt is the main way to eliminate potholes from developing through freeze and thaw cycles. A planned road program for the INEEL is in the conceptual phase, which may be modified to include using the ash.

3.4.2.2 Volumes of Ash that Can Be Used. The quantity of ash that could be used is limited only by the number of roadway applications that can be identified.

3.4.2.3 Implementation. To use the ash from the existing bury pit, an additional roadway to the excavation site in the pit would need to be built. This additional roadway would allow excavation in the pit while the process of dumping ash into the pit could continue. Excavated ash would be taken to a grinder at a lay-down location adjacent to the pit. Ash would be run through the grinder and transported via truck to a subcontractor designated area for processing for use in the roadway.

If ash was used directly from the plant, a new mixer would need to be installed at the existing silo. Ash would then be placed into a truck from the mixer on the silo. Ash would then be transported via the truck to a subcontractor designated area for processing for use in the roadway.

Ash used for road base is a viable option, but is not considered one of the primary options in this report. The road base alternative would take 5 months from start to putting ash into reuse (3 months for design and review and 2 months for bid). The 5-month cycle assumes ash could be used as soon as the bid is awarded.

3.4.2.4 Costs. The following costs are estimated values for individual scopes of work. The complete cost estimate is provided in Appendix G. The estimates include costs for construction, engineering, management, and overhead adders. For each alternative, the applicable portions of the cost estimate were used to provide the total estimated cost of implementation as shown below:

This cost estimate assumes that the existing ash bury pit would be used to supply the raw material for road base. If dry ash from the silos is selected, a similar cost estimate can be generated by using the applicable section of the cost estimate provided.

Table 5. Cost breakdown for Soil Stabilization alternative.

Scope of Work Required to Implement	Estimated Cost
Additional roadway:	$123,816
Excavation of bury pit at 1,000 tons	$369,565
Mixer	$170,000
Transportation of 1,000 tons	$20,800
Total:	$684,181

3.5 Waste Remediation

3.5.1 Description

The pH, water absorption tendency, and cementitious properties of AFBC ash provide many opportunities for use in waste stabilization. This applies to activities at the INEEL and in the local community. For this report, only the stabilization of raw sewage removed from septic tanks will be discussed.

Local septic tank contractors currently are required to raise the pH of the raw sewage to a value of approximately 9 pH for about 30 minutes, heat the sewage for pasteurization, remove the water (creating a dry material), then dispose of it in county landfills.

In the treatment of raw sanitary sewage sludge, the unreacted lime and $CaSO_4$ anhydrite are effective in pasteurization and provide for alkaline stabilization. The hydration of the lime and gypsum release heat that in connection with the alkaline conditions pasteurize the waste, eliminating pathogens and most odor-causing bacteria. The final granular product is suitable for use in agriculture, land reclamation, and as landfill cover. The final soil-like material has good physical handling characteristics, has low odor and odor potential, has a pleasing, acceptable appearance, and can be readily spread with existing equipment.

3.5.2 Volumes of Ash Needed

The quantities of ash that can be used for waste remediation are not known at this time. This alternative is highly dependant on the willingness of local septic tank cleaning businesses to modify their operations in a manner that would allow use of the ash.

3.5.3 Implementation

As was discussed in the alternative for landfill day-covers, dry nonhydrated ash can be obtained by two methods. First, from the existing ash silo that contains a stratified mixture of spent bed material, economizer ash, and bag house ash. Second, a second ash silo can be installed so that the spent bed material can be collected separately from the economizer and bag house ash.

Further analysis would need to be performed on the existing ash silo mixture to verify if the fluctuations in ash constituents can be accepted for the stabilization of raw sewage. At this time, we assume that the fluctuations in ash constituents, in the existing ash silo, can be handled by the process to stabilize raw sewage. This means that the first method for obtaining the ash can be used with no further modifications to the existing facility.

Additional work would be required by the INEEL and also the local septic tank cleaning businesses to implement this alternative. New equipment would most likely be required by the septic tank cleaning businesses to utilize the ash in their process. In addition, an environmental assessment would be needed to ensure that the heavy metals and other compounds present in the ash would not create a more hazardous waste than what the sewage sludge already is. A process exists that would remove heavy metals from fly ash. This process should be reviewed and its cost effectiveness considered if heavy metal removal is later considered to be required.

Ash used for waste remediation is a viable option, but is not considered one of the primary options in this report. The waste remediation alternative would take 7 months to implement (3 months for design and review, 2 months for bid, and 2 months for construction).

3.5.4 Costs

The costs associated with implementation of this alternative are difficult to determine since the equipment needed, and the political hurdles that would need to be overcome, are not completely known at this time.

3.6 Carbon Recovery Technology

Mineral Resource Technology, a subsidiary of Phillips Brothers, was contacted concerning Carbon Recovery Technology for Coal Fly Ash. Mineral Resource Technology has a license from Michigan Technological University for the recovery process. The Process is as follows:

The coal-fired plant's fly ash is placed in a wet process where the carbon in the ash is allowed to float to the top of the solution. The carbon is then skimmed from the solution. The remaining solution is dried leaving ash that has a 1% maximum carbon content. The ash is then sold for use in commercial grade pozzolan concrete. The carbon that is 65–90% pure is also sold to companies like those in the rubber industry.

Mineral Resource Technology is presently using large-scale utility companies' coal-fired plant ash. Costs incurred from the carbon recovery process have limited the use to plants producing 100,000 tons of ash per year as a minimum. Smaller plants do not produce enough ash to return a profit from this process.

As the INTEC coal-fired plant normally produces less than 1,000 tons of ash per year, a carbon recovery process of this type is not viable. Though Mineral Resource Technology has competitors in this industry, it is assumed that no further review of this process is needed at this time as our quantities of waste are only 1% of that required to make it cost effective.

4. ENVIRONMENTAL ASSESSMENT CONSIDERATION

The Architectural/Engineering group at LMITCO contacted the Policy and Permitting section of the INEEL Environmental Affairs Branch for an interpretation of the regulations that would apply for the potential reuse of the CPP-687 fly ash. As a result, decision #43 was entered into the Environmental Issues and Compliance Reporting system. This decision is summarized below and the complete National Environmental Policy Act (NEPA) interpretation is included in Appendix B.

> "To go forward with using the ash as a feed stock, the project proponents would need to submit an environmental checklist addressing the proposed activity to Environmental Policy and Permitting for review and approval. Policy and Permitting would evaluate the environmental checklist and recommend to DOE-ID how the activity should be covered under NEPA. DOE-ID would then approve our recommendation or give us specific direction to do it another way. As part of the review process, Policy and Permitting would identify any other regulatory requirements, such as obtaining permits, that would be required to start the activity."
>
> "Use of a by-product material from one activity (operation of the coal-fired plant) as feed material for another activity is not specifically addressed in the DOE lists of categories of activities. A clause in the DOE NEPA regulations specifies that in such a circumstance, an EA is required unless DOE has already decided to prepare an EIS. In this case, there appears to be little justification for an EIS but I have discussed the matter with the DOE NEPA personnel who believe that an EA is appropriate. See discussions of potential liability below. EAs at the INEEL generally take from 8 to 10 months from the time they are authorized by DOE and cost in the range of $60K to $80K."

5. CHARACTERIZATION OF RAW MATERIALS USED IN THE INTEC COAL-FIRED PLANT

5.1 Coal

The coal burned in the coal-fired plant is classified as "high-volatile B bituminous" coal. The current source is from the Sufco mine in Utah.

5.2 Limestone

Limestone is supplied by Treasure Canyon Calcium from Preston, Idaho to meet the following specifications: 97% minimum Calcium Carbonate; <0.28% Magnesium Carbonate; <0.2% Ferrous Oxide; <2% all other solubles.

5.3 Inert Bed Material

Ione Fluid Grain is used in conjunction with the limestone for the inert bed material. This material consists primarily of silica (SiO_2) and alumina (Al_2O_3).

5.4 Trash Pellets

In addition to the coal that is used for fuel, trash pellets are also burned in the boilers. The pellets are made from routine trash generated at the INEEL. Routine trash includes paper, wood, cardboard, food items, styrofoam, plastics, paper towels and just about any other item that is routinely placed in trash that can be burned. Typical concentrations of pellets to coal is in the range of 25–30%.

5.5 Ongoing Fuel Testing

A Bio-lime Test is scheduled at the facility for April 20, 1998. The test consists of three burns of paper pellets with a 50-ton straight coal burn as a buffer followed by three burns of paper pellets coated with bio-lime. The test will involve two cell operation venting and will last approximately eight days. Paper pellets are generated at INTEC using trash, waste paper, and waste plastic collected at INEEL facilities from garbage.

Ash samples will be collected at various times during the test. Some samples should be collected for additional ASTM physical and chemical testing. This round of testing should also be evaluated for possible reuse of the ash or for changes to any planned reuse of the existing ash.

6. ASH CHARACTERIZATION

Samples of the ash produced by CPP-687 were collected and characterized in accordance with ASTM D5759, "Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses." The samples were collected from a total of five sources. The sources included spent bed material, economizer ash, bag house ash, ash silo, and the hydrated pit material. The results of the chemical and physical tests are provided below.

6.1 Chemical Testing

The chemical tests were performed by the Wyoming Analytical Laboratories, Inc. and Commercial Testing & Engineering Co. to determine the chemical composition of the samples. The major chemical constituents of each sample were evaluated to characterize their classification based on ASTM requirements for commercial fly ash. Table 6 below shows the minimum and/or maximum percentage of each constituent for the various classes of commercial fly ash per ASTM Standards.

The chemical constituents for the various fly ash samples were plotted against ASTM Class C and Class F baseline to determine their classification. Several plots of the major constituents necessary to the classify the samples as Class C or Class F are shown below. However, note from Table 6 that all the major constituents must be present for categorizing as Class C or Class F commercial fly ash. Figure 1 below shows the average value of the generated ash samples for the subtotal of "SiO_2+Al_2O_3+Fe_2O_3" in reference to the ASTM C618 Class C or Class F commercial fly ash. The samples must have a subtotal weight greater than 50% for Class C fly Ash characterization or a weight greater than 70% for Class F. To see the complete test reports that provided data for the figures, see Appendices D and E.

Table 6 also shows the average values of INTEC generated ash samples by weight percentage for the Calcium Oxide (CaO) compound. The ASTM requirements show that the CaO or lime content for Class C Commercial Fly Ash characterization is approximately 10%. Appendix F contains the complete ASTM Standard. The high concentrations of lime are due to the burning process within the coal-fired facility. The addition of lime in this process is used to reduce sulfur emissions.

Table 6. Comparison of INEEL ash sample results to ASTM standards.

		ASTM	ASTM C618			ASTM C5		
		C150 Cement Type II	Pozzolan Class N	Fly Ash Class F	Fly Ash Class C	Calcium Lime	Magnesium Lime	All Sample Average
Silicon dioxide	SiO_2	>20%						32.1%
Aluminum oxide	Al_2O_3	<6%						8.9%
Iron oxide	Fe_2O_3	<6%						2.5%
SiO_2+AL_2O_3+Fe_2O_3	Subtotal		>70%	>70%	>50%	<5%	<5%	43.4%
Calcium oxide	CaO				≅10%	>75%		34.4%
Magnesium oxide	MgO	<6%					>20%	1.4%
CaO+MgO	Subtotal					>95	>96%	35.8%
Sulfur trioxide	SO_3	<3%	<4%	<5%	<5%			3.1%
Loss on Ignition	LOI	<3%	<10%	<6%	<6%			13.8%
Moisture Content			<3%	<3%	<3%			0.5%

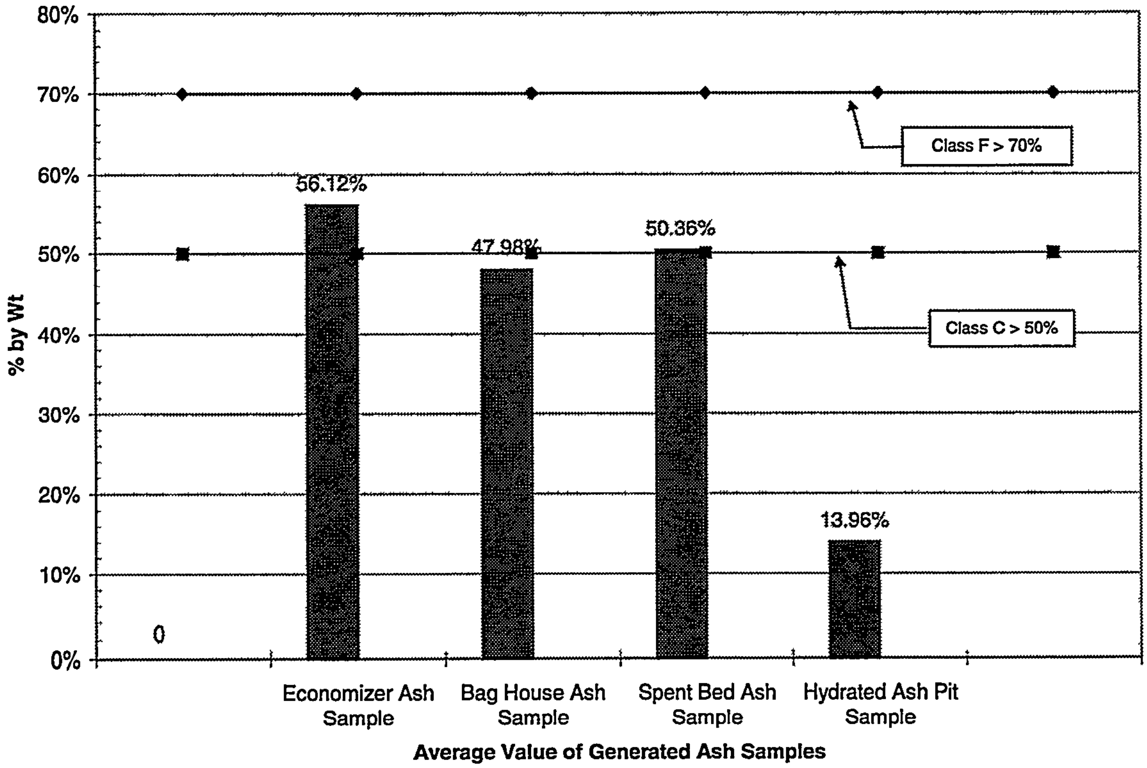

Figure 1. Classification range of the coal-fired generation facility fly ash samples for $SiO_2 + Al_2O_3 + Fe_2O_3$ based on ASTM C618 Class C and F Fly Ash requirements.

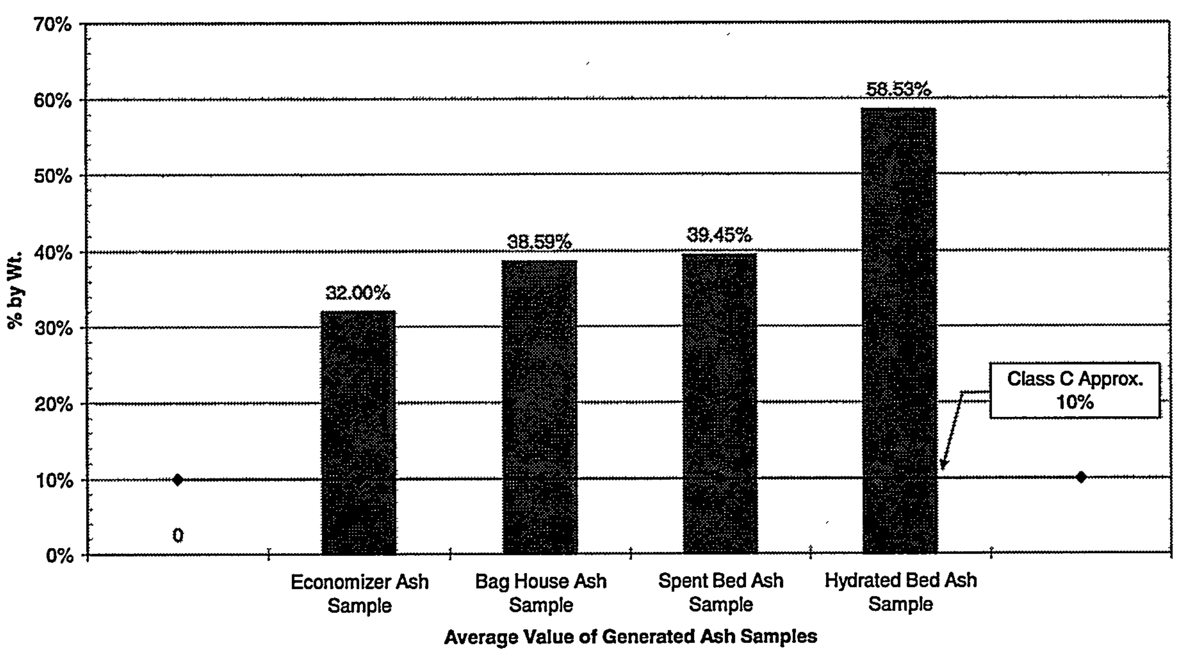

Figure 2. Classification range of the coal-fired steam generation facility fly ash samples for calcium oxide (CaO) based on ASTM C618 Class C Fly Ash requiremensts.

Figure 3 below shows the average percentage of sulfur trioxide (SO_3) present in the INTEC generated ash samples. The samples must have a sulfur trioxide content less than 5% to be an ASTM C 618 Class C or F Commercial Fly Ash category.

Figure 4 displays the percentage of Loss on Ignition for the individual samples. This test is performed to determine the amount of carbon present in the ash sample. The Loss on Ignition for a class C or Class F characterization should be less than 6%.

Figure 5 shows the amount of moisture present in the samples. ASTM C618 requires a moisture content less than 3% for a Class C or Class F category.

Figure 6 shows the average pH balance values for the samples.

Figures 7–10 show the nonessential compounds found in the Economizer, Bag House, Spent Bed, and Hydrated Bed ash samples. Theses compounds are not required in assessing the fly ash classification.

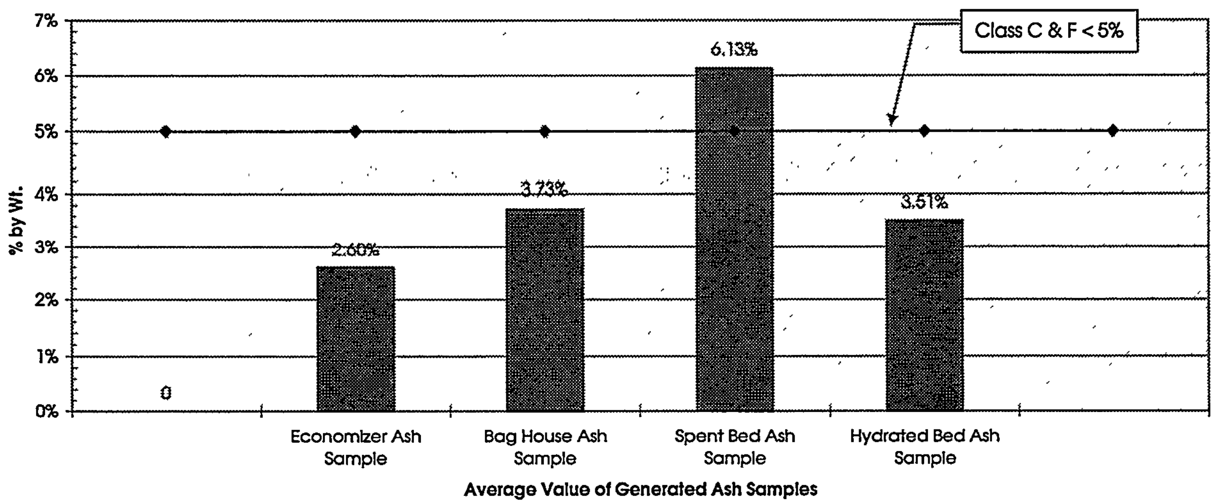

Figure 3. Average value of SO_3 present in generated ash samples.

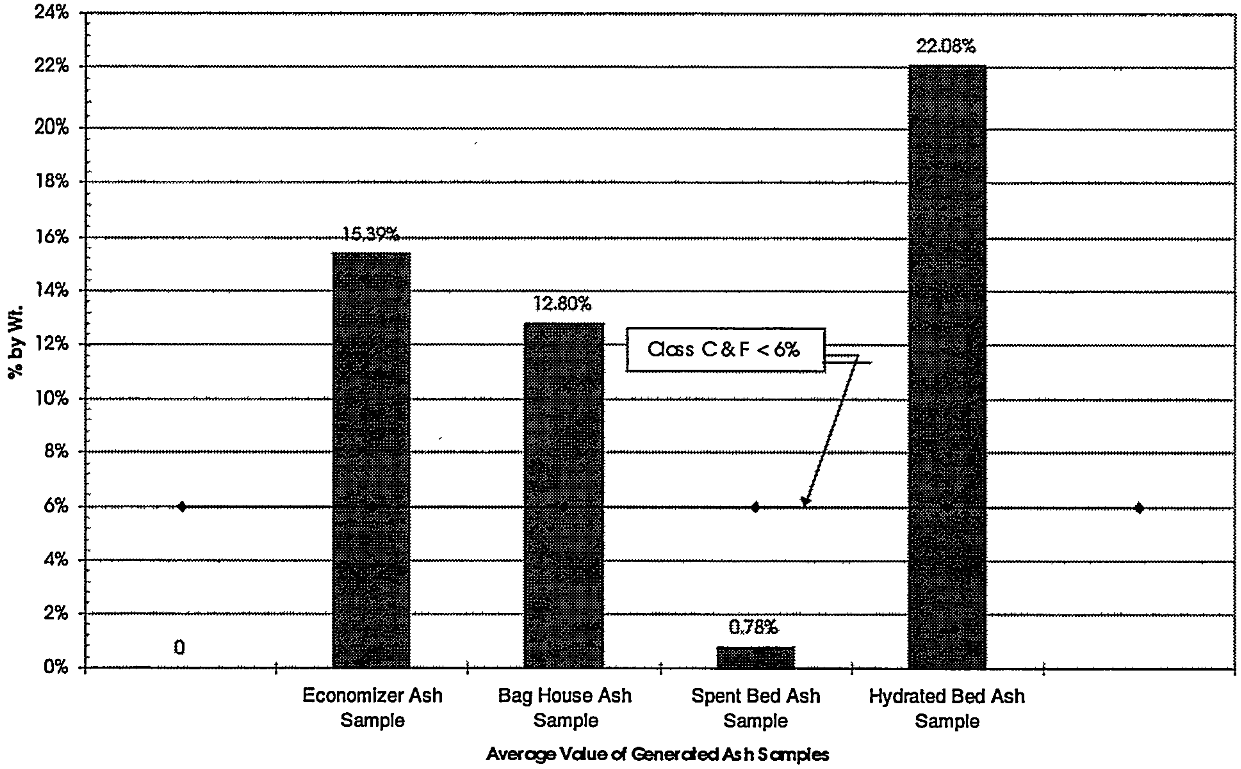

Figure 4. Classification range of the coal-fired steam generation facility fly ash samples for loss on ignition based on ASTM C618 Class C & F Fly Ash requirements.

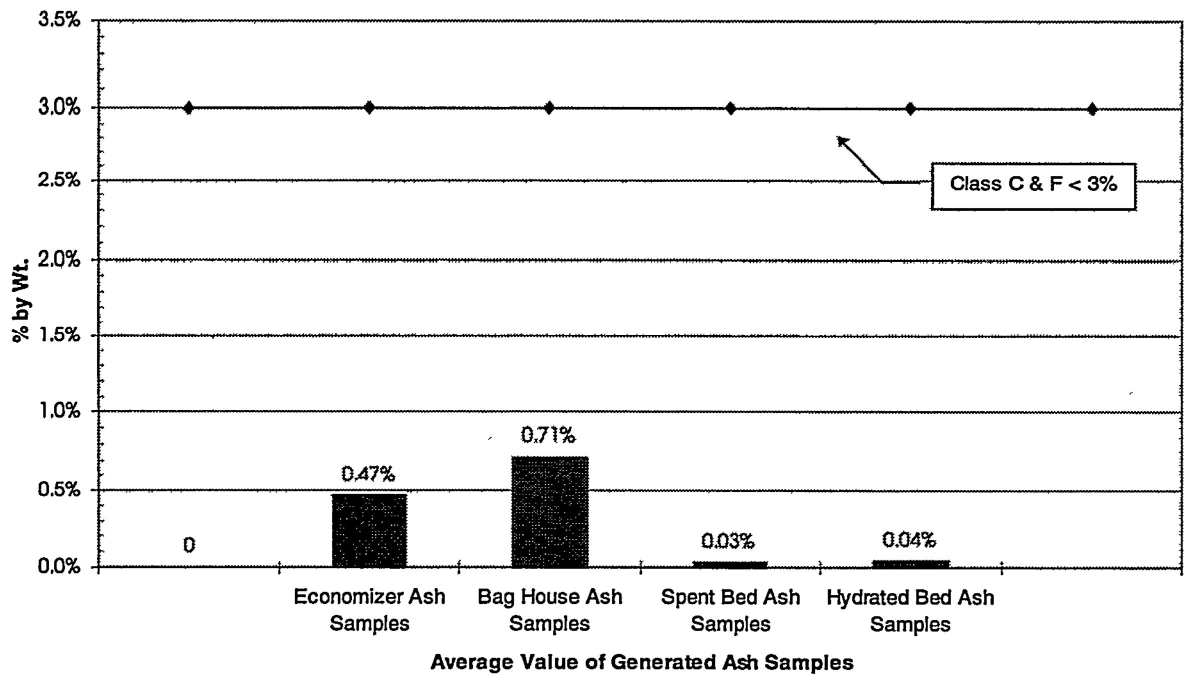

Figure 5. Classification range of the coal-fired steam generation facility fly ash samples for moisture content based on ASTM C618 Class C & F fly ash requirements.

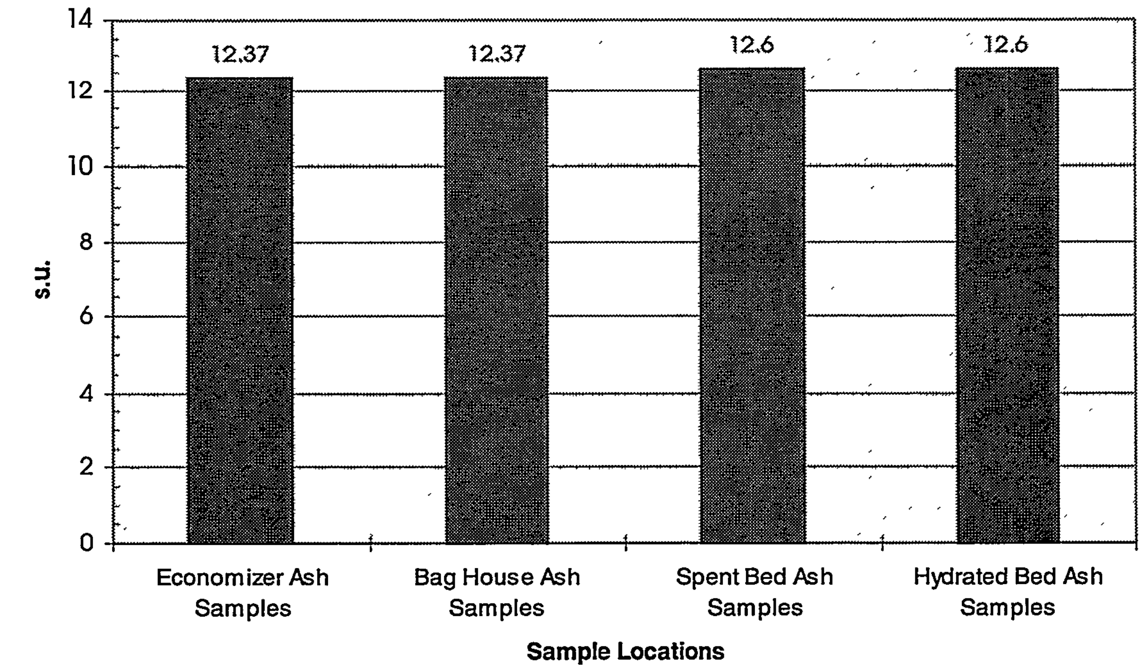

Figure 6. Average pH values for the various samples.

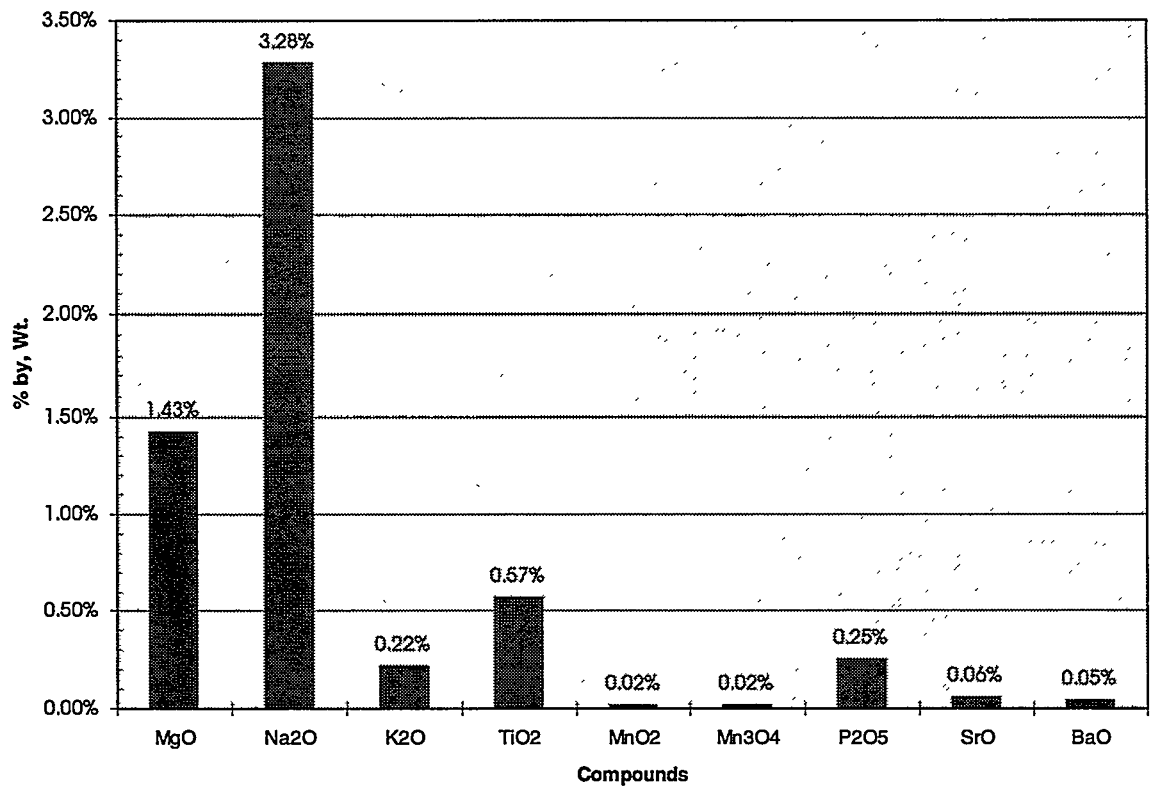

Figure 7. Average values for nonessential compounds found in economizer ash samples.

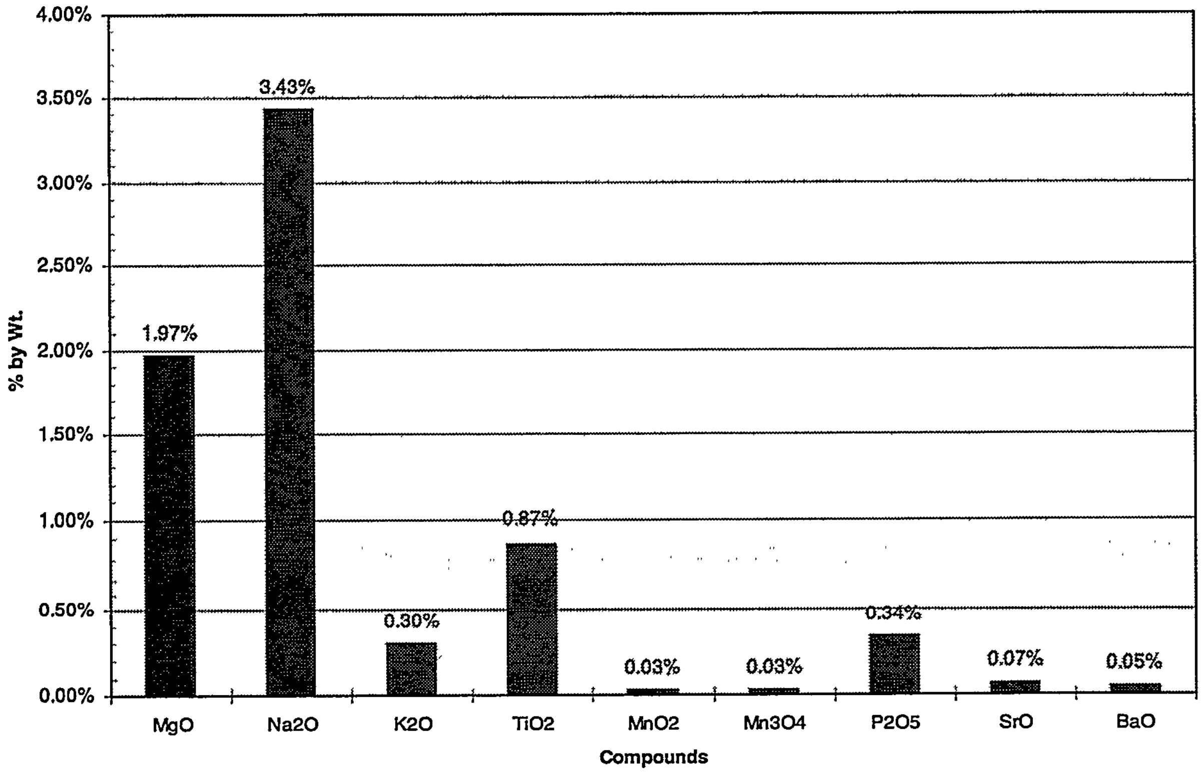

Figure 8. Average values for nonessential compounds found in bag house ash samples.

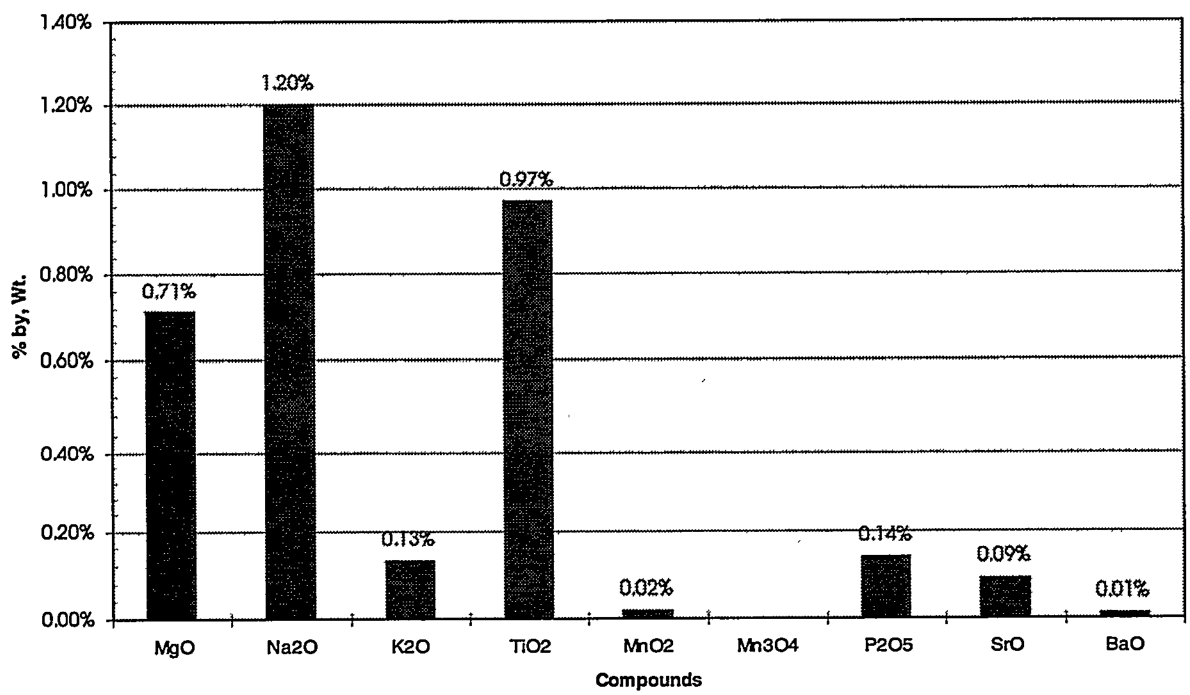

Figure 9. Average values for nonessential compounds found in spent bed ash samples.

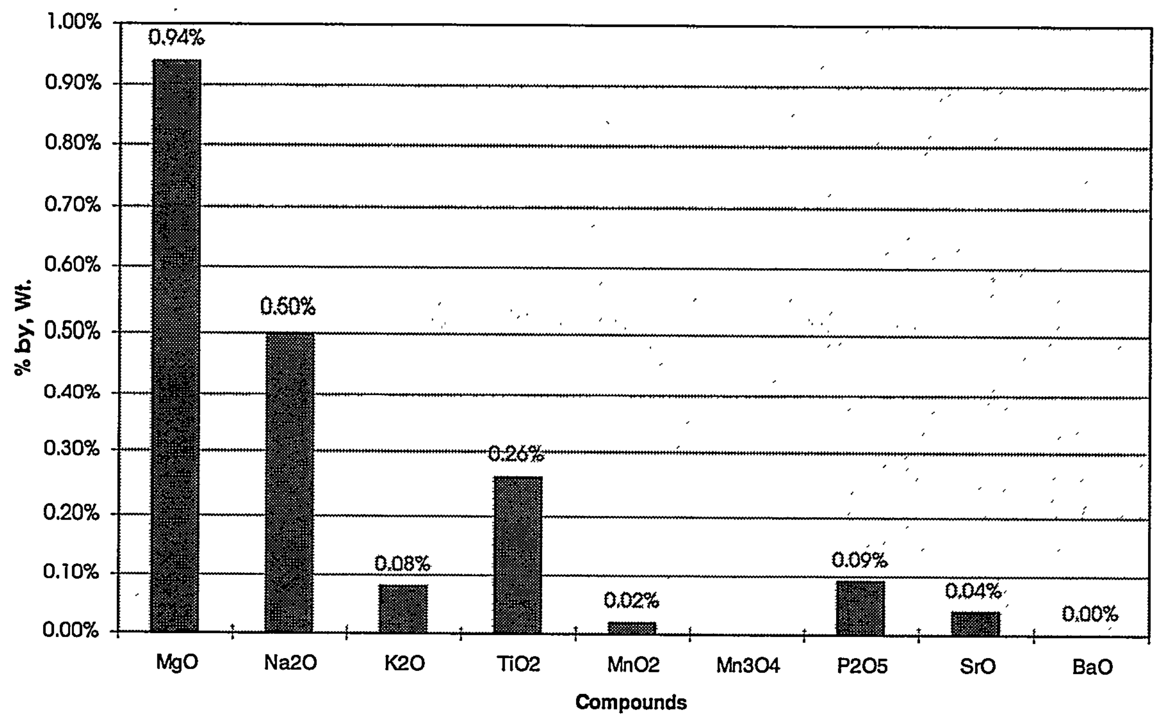

Figure 10. Average values for nonessential compounds found in hydrated bed ash samples.

6.2 Physical Testing

Physical testing of the fly ash from the facility and the existing ash pit was performed by LMITCO's Material Testing Lab at Central Facilities Area. Samples were taken in January 1998 from the existing pit and from the three ash sources within the facility, which consist of spent bed material, economizer, and bag house hoppers. The testing of the ash samples was done per ASTM C311-90 "Test Method for Sampling Fly Ash or Natural Pozzolans for Use as a Mineral Aggregate in Portland Cement Concrete." The Material Testing Lab's report is attached in Appendix C and summarized here.

The ash samples from the facility were first hydrated; the ash in the existing pit has all ready been hydrated during transportation to the ash bury pit. Samples from the facility, once hydrated, generated heat (150–200°F) and expanded a great deal.

Mixes were conducted on the four main ash streams: Spent Bed, Economizer, Bag House, and Ash Pit. A series of 2 × 2-in. cubes were made for compressive strength testing. Cubes made included fly ash and water, cement and water, commercial fly ash and cement, and ash from each stream with cement at 50–50% mixtures and at 65% ash and 35% cement. Results of the compressive strength tests showed that the 50–50% mixes had 28-day strength of 1,838–3,363 psi.

Other tests performed include Loss on Ignition, Percent of Shrinkage, Specific Gravity, Sieve Analysis, and moisture content. Results of the testing are given in the attached Tables and Charts. Evaluation of the test results for reutilization alternatives are discussed throughout this report.

The physical data was gathered by Craig Bean of the Materials Testing Laboratory located at the Central Facilities Area. Samples were formed into cubes and tested for their compressive strength. These samples were evaluated using a cement mix ratio of 50% cement and 50% ash, 35% cement and 65% ash. These mixes were compared with the compressive strength of 100% cement and no ash, 50% commercial ash mixed with 50% cement, and 65% commercial fly ash mixed with 35% cement. Table 7 shows the test batches with the various cement ratios.

Table 7. Compressive strength test results for fly ash mixed with cement.

Test Batch Description	Test Batch No.	Compressive Strength Days 0	5	7	14	28	42
Cement Only - No Ash	#1	0	6,200	8,419	10,275	11,363	11,613
Baghouse Ash with 50% Cement	#2	0	1,757	2,269	2,982	3,313	4,207
		0	4	7	14	28	42
Spent Bed with 50% Cement	#3	0	682	1,157	1,419	1,851	2,282
Hydrated Bed Ash Pit with 50% Cement	#4	0	969	1,501	1,938	2,007	2,050
		0	3	7	14	28	42
Baghouse Ash with 35% Cement	#5	0	347	1,001	1,332	1,732	1,757
Hydrated Bed Ash Pit with 35% Cement	#6	0	238	401	626	594	597
Economizer Ash with 50% Cement	#7	0	1,281	1,957	2,275	2,813	2,957
Commercial Ash with 50% Cement	#8	0	2,469	4,601	7,276	7,863	10,350
Commercial Ash with 35% Cement	#9	0	2,032	3,819	4,857	5,225	6,063
Average of CPP Materials	Avg.	0	879	1,381	1,762	2,051	2,308

The comparison of the 50% fly ash with 50% cement is shown in Figure 11. The graph clearly shows that the fly ash is not suitable for structural grade concrete since the samples' compressive strength averages are lower than 4,000 psi. Figure 12 shows the strength for samples with 35% concrete, and Figure 13 provides an overall comparison of the various ash samples.

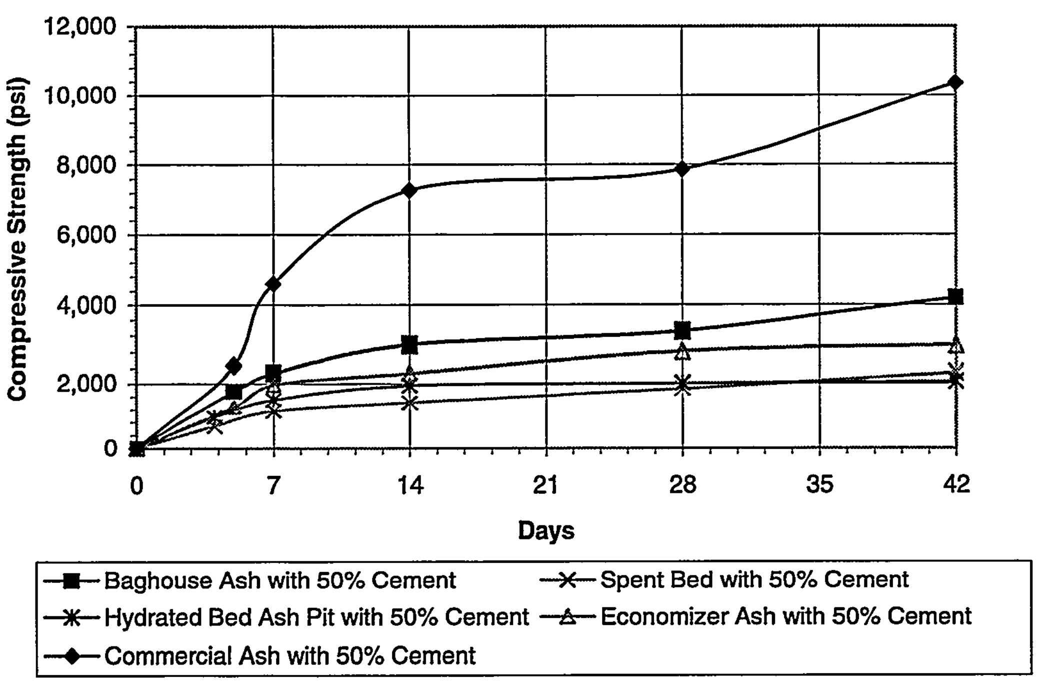

Figure 11. 50% cement evaluation sample strengths.

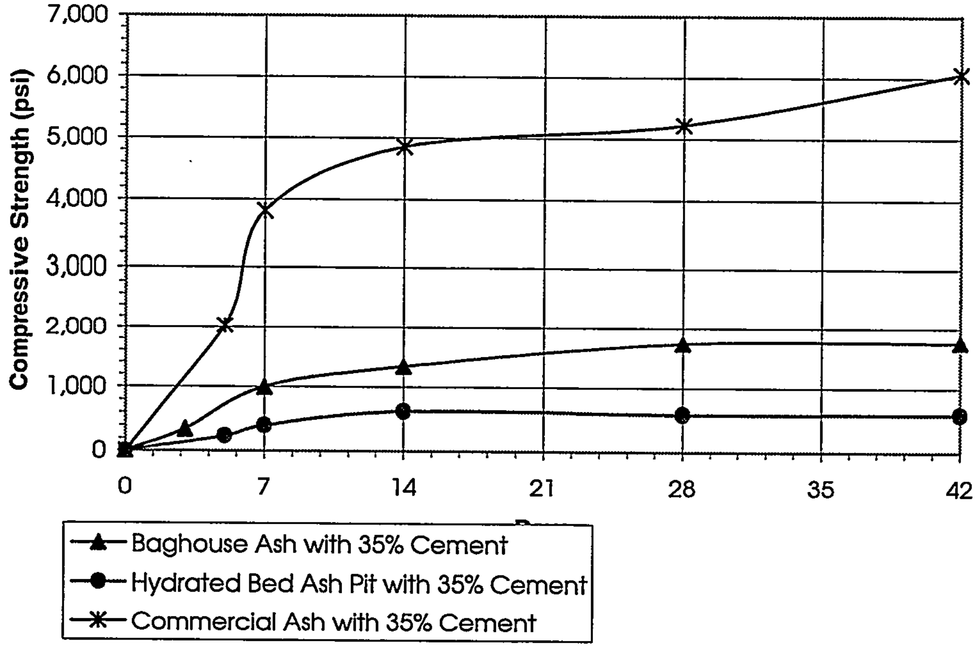

Figure 12. 35% cement evaluation sample strengths.

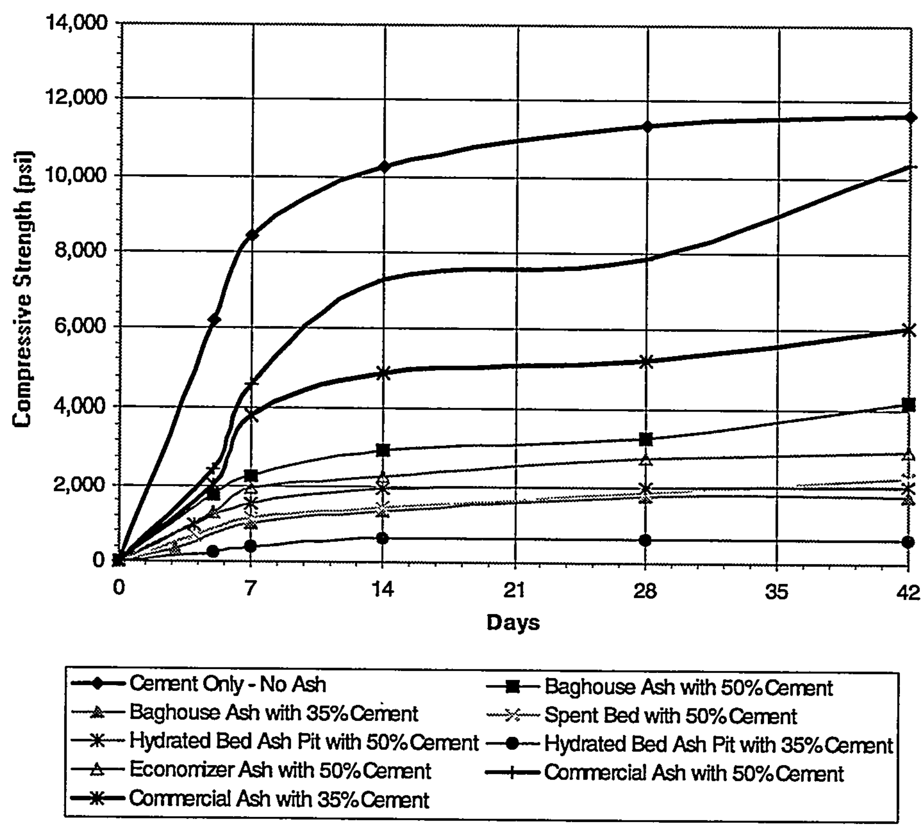

Figure 13. CPP ash pit overall comparison of sample strengths.

6.3 Ash Availability

The AFBC boilers consume approximately 13,000 tons of coal per year. The ash production rate is about 7.5% of the coal input. This equates to about 975 tons of ash per year.

Currently there are three sources within the AFBC boilers that produce this ash: the spent bed material, the economizer, and the bag house hoppers. All three of these sources are partially blended in the dry ash silo for later disposition. If required by the potential reutilization selected, the vacuum ash lines can be modified and new ash silos can be installed to separate the three sources.

7. RECOMMENDATIONS

After reviewing all of the alternatives that were identified in this study, the most viable option is Flowable Fill (Section 3.3). The ash generated by the CFSGF and the hydrated ash bury pit should be used in flowable fill concrete for D&D work at the INEEL. A number of facilities are presently scheduled to be demolished, and their basements, cells, or underground vessels are to be filled with flowable fill. Ash can be taken directly from the plant's silo with pretreatment or excavated from the pit without pretreatment and can partially or completely eliminate the need for commercial grade fly ash.

Using the ash in flowable fill would eliminate a waste stream at the INEEL, generate a cost savings of $1.7 million by eliminating the need for a new ash bury pit, and reuse the waste ash on projects that would otherwise require the purchase of additional materials. The implementation costs associated with this reutilization would be offset by cost savings as less commercial grade ash would need to be purchased for the D&D work at the INEEL. The three potential projects listed in this report plan on using over $500,000 of commercial-grade fly ash.

The second most viable option would be to use the ash for Landfill Day Cover (Section 3.1). This alternative would only use the ash from the CFSGF and not from the existing ash bury pit. This alternative minimizes the volume of fill placed in the landfill, lengthening the life of the landfill while minimizing the need for large earth-moving equipment to spread soil day cover.

Because the existing ash bury pit will be filled to capacity in FY 1999, within 1 year, any ash reutilization alternative would need to be started in time to create space in the existing bury pit. Extending or adding onto the existing pit would not allow as great a cost savings. If the reutilization options cannot be accomplished in the lifetime of the existing pit and the temporary use of the percolation pond is not found viable, then it is recommended that a pit modification project be started immediately.

The option for temporary ash disposal is to use one of the existing percolation ponds located at the south end of INTEC. The southeast pond is no longer in use, is close to the coal-fired plant, has existing truck accesses that could be used, and is large enough for years of use. If used for an interim ash disposal location, the percolation pond could be lined, the ash could be temporarily placed in the pond, and excavated at a later time for reuse.

The new pit construction cycle is 11 months (3 months for design and review, 2 months for bid, and a 6 month construction period). The flowable fill alternative would take 5 months from start to putting ash into reuse (3 months for design and review and 2 months for bid). The 5-month cycle assumes ash could be used as soon as the bid is awarded. The day cover alternative would take 7 months to implement (3 months for design and review, 2 months for bid, and 2 months for construction).

Any alternative requires a commitment from the INEEL to reuse the ash. As this report demonstrates, several viable alternatives exist. Additional testing would be required on any alternative presented to determine the specific reutilization technique needed. Also, per the NEPA interpretation (Appendix B), any reuse of the ash will require a new Environmental Assessment (EA). A new EA would cost from $60,000 to $80,000 and take 8 to 10 months to accomplish.

Appendix A
Points of Contact

Appendix A
Points of Contact

Company	Point of Contact	Phone #	Notes
LMITCO	Steve Butterworth, Project Management	(208) 526-3705	Ash Reutilization Project Manager
LMITCO	Terry W. Chesnovar INTEC Utility Operations	(208) 526-3959	
LMITCO	Mike Lewis INTEC Environmental Support	(208) 526-5944	
LMITCO	Scott A. Jensen - PE Civil Engineer	(208) 526-0544	Flowable Fill & Grout Resource
LMITCO	Craig Bean Construction Mgmt	(208) 526-2588	Physical Testing of Concrete Samples
Foster Wheeler	Robert L. Svendsen Project Manager	(540) 341-7437	Expert on coal ash management
Foster Wheeler	Jim Utt Manager of Marketing	(719) 685-1986	Local Representative
Dust Master Enviro Systems	Carl F. Isonhart Product Manager	(414) 691-3100	Manufacturer of mixer/hydrator
Landfill Services Corporation	Joseph M. Missavage National Sales Manager	(800) 800-7671	Posi-Shell Cover Salt Lake Co. Landfill is using their system
AMCOR	Dave Peters	(208) 522-6150	No interest
AAA Sewer Service	Mike Poliski	(208) 522-6557	
Bonneville Co. Landfill	Bill Manwill	(208) 529-1290	
Madison Co. Landfill	Wendal Roth	(208) 356-3102	Hauls their trash to Jefferson Co.
Jefferson Co. Landfill	Parley Williams	(208) 663-4406	Lots of space and dirt. Would cost $100/ton to dispose of our ash. Cost would be considerably less if the ash is hydrated.
Bannock Co. Landfill	Tom Hepworth	(208) 238-7209	Looking at alternatives and environmental concerns
Bingham Co. Landfill	Neil Morgan	(208) 785-5005	

Company	Point of Contact	Phone #	Notes
INEEL Landfill	Mel P. Wraught Operations	(208) 526-5038	
INEEL Landfill	Lester Shepherd Waste Coordinator	(208) 526-8019	
Mineral Resource Technology	Daniel Benthime	(770) 989-0089	Carbon Recovery
Michigan Technological University	Sandy Gayk	(906) 487-3429	Carbon Recovery

Appendix B
NEPA Interpretation

Appendix B
NEPA Interpretation

Tracking Number 43
Submittal Date 3/4/1998
Topic NEPA
Approval Date 3/4/1998

Issue Description

The Architectural Engineering (A/E) group is performing a study, for CPP, to look at ALTERNATIVE USES for the ash produced by the steam generating facility CPP-687. This study is a precursor to the design and construction of a new ash pit that will be required in the near future. The viability of proposed alternatives will impact the design of the new ash pit.

The A/E group would like to a determination and/or a single point of contact that can define the ramifications that would be faced if we try to reuse this ash for another purpose.

The CPP-687 steam generator is a fluidized bed boiler and the ash is said to be exempt from regulation even though the ash produced is considerably different than that produced by commercial coal-fired power generators.

The A/E group will be producing a report that characterizes the ash, discusses alternative uses possible, and provides recommendations for the best alternative. As part of this report, we would like to include an overview of what the regulation requirements (or show stoppers) may be from a compliance standpoint. If these issues are substantial, it will affect our recommendation.

Some of the potential uses that are being considered at this time include:

1. Flowable fills for D&D filling of basements at CPP and other areas
2. Soil Stabilization
3. Covers over sewage ponds
4. Mix with waste latex paint and spray on landfills to provide a day cover
5. Backfilling of trenches during construction
6. Decorative blocks for landscaping
7. and the lists can go on....

There are essentially three components of the steam generators that contribute to the ash coming from CPP-687, they are; economizer, bag house and spent bed material. In addition to looking at these sources of ash for reutilization, we are also looking at the possibility of "mining" the existing ash pit material for reutilization. Feel free to contact me if you have further questions or need additional information. Again, we are looking for any snags that may come up concerning this type of effort.

Supporting Documents

NEPA exclusion for coal-fired ash disposal????

Discussion

Coal ash is currently exempt, will it be regulated if it is used for another product????

Decision

There are several questions here, some of which relate to NEPA (Are the various activities categorically excluded?), another relates to RCRA (Is coal ash excluded from regulation?), and probably some relate to such areas as INEEL liability for materials and products that we provide (What are the potential consequences of using this material as a feed stock?). Some of these I can answer (NEPA-related questions), some I can get answers for (RCRA-related questions), and some I have environmental-related opinions on, but don't necessarily have definitive INEEL answers (liability-related questions).

First question: Is there a NEPA exclusion for coal-fired ash disposal. Answer: No, the DOE NEPA regulations don't work that way. Explanation: I assume that the question relates to the NEPA term "categorical exclusion." Under NEPA, a categorical exclusion is an activity that by its general nature has been consistently found, based on agency (DOE) experience, to not have a significant effect on the human environment and is, therefore, categorically excluded from the need to prepare an environmental assessment or an environmental impact statement. The DOE NEPA regulations have defined categorical exclusions in very broad categories, such as those applicable to facility operations and those applicable to safety and health. The DOE NEPA categorical exclusions are essentially based on knowing why an activity is being conducted rather than knowing specifically what the activity is. Consequently, for example, construction of any support facility for any routine facility operation could potentially be categorically excluded if it met certain other requirements related to whether or not it is connected to other new activities that also require NEPA documentation or whether it had any extraordinary circumstances associated with it. An example of an extraordinary circumstance might be the need to construct the facility in a wetland. In addition to defining their categorical exclusions, the DOE NEPA regulations also define categories of activities that normally require the preparation of environmental assessments and categories of activities that normally require Environmental Impact Statements.

In this particular instance, several things have already taken place and several more would be required before any new ash pit could be constructed or operated. First, a research activity is being undertaken on the fly ash to determine its properties and investigate potential uses. For this purpose, the program contact, Steve Butterworth, submitted an environmental checklist to Policy and Permitting for processing. We reviewed it, and recommended to DOE that the activity, as described in the environmental checklist, be categorically excluded as a Site characterization/environmental monitoring activity (Categorical Exclusion B3.1 on the DOE list of categorical exclusions). DOE concurred with our recommendation and the environmental checklist was approved on 3/9/98. This specific activity is generally limited to the investigation of the properties and potential uses of the ash and preparation of a report. Use of the ash as a feed stock or construction of a new pit would require submittal and approval of another environmental checklist. To go forward with using the ash as a feed stock, the project proponents would need to submit an environmental checklist addressing the proposed activity to Environmental Policy and Permitting for review and approval. Policy and Permitting would evaluate the environmental checklist and recommend to DOE how the activity should be covered under NEPA. DOE would then approve our recommendation or give us specific direction to do it another way. As part of the review process, Policy and Permitting would identify any other regulatory requirements, such as obtaining permits, that would be required to start the activity.

Use of a by-product material from one activity (operation of the coal-fired plant) as feed material for another activity is not specifically addressed in the DOE lists of categories of activities. A clause in the DOE NEPA regulations specifies that in such a circumstance, an EA is required unless DOE has already decided to prepare an EIS. In this case there appears to be little justification for an EIS but I have discussed the matter with the DOE NEPA personnel who believe that an EA is appropriate. See discussions of potential liability below. EAs at the INEEL generally take from 8 to 10 months from the time they are authorized by DOE and cost in the range of $60K to $80K. DOE determines which contractor will prepare the EA, sometimes its LMITCO, sometimes it is an outside contractor.

Construction and operation of a new ash pit appears to have been addressed in the Environmental Assessment for Coal-Fired Steam Generation Facility (Idaho Chemical Processing Plant), dated May 20, 1981. This document is the NEPA document for construction and operation of the Coal-Fired Plant. In the Environmental Assessment it states, in section 1.2.7.4, "An ash burial pit will be used to dispose of the wastes. A covered truck will transfer the wastes from the silo and baghouse to the disposal pit. A disposal pit, 250 × 210 × 20 ft deep, will contain the ash from the first ten years of operation. Space will be provided for another pit to accommodate waste generated from the next fifteen years of operation." If the currently proposed pit is bounded by the description in the 1981 EA, then no additional NEPA documentation would be needed. If the currently proposed pit exceeds the bounds of set by the EA, then additional NEPA documentation would be required. An environmental checklist describing the proposed new pit should be submitted to Environmental Policy and Permitting for review and determination of whether or not additional NEPA documentation is required, and for determination of other permitting requirements. The matter of exemption of coal ash is not a NEPA question, rather it is a RCRA question. Coal ash is to be disposed is a solid waste under RCRA, but it is excluded from regulation as hazardous waste under 40 CFR 261.4(b)(4), irrespective of its constituents.

If the ash is being used as a feed stock for a product, it is not a waste and is not regulated under RCRA. However, the resulting product, if it is off-specification or has to be disposed of for some reason, would need to be evaluated under the RCRA regulations and might turn out to be a hazardous waste depending on its constituents. When considering potential liability, the constituents of the ash, the products made from it, and the uses of the products all have to be considered. As an example, coal ash has Ra-226 in concentrations about 20 times greater than in the coal. In some cases this can result in significant concentrations of Ra-226, and significant generation of Rn-222. Use of a feed stock with elevated radium concentrations for a building block to be used in residential construction might have unacceptable health consequences to the residents and might be something we don't want to do. As another example, fly ash may have significant concentrations of heavy metals that might make the product a hazardous waste at the time of disposal, again something we might not want to do. I believe that the environmental assessment that would be required to use the coal ash as a feed stock is the appropriate vehicle for examining the potential consequences of the alternative uses. DOE would make the ultimate decision on which, if any, of the alternatives would be implemented. Because of the analysis provided in the EA, DOE's decision would be made with knowledge and acceptance of the consequences.

The proposed activities will have impacts in a number of regulatory areas, and there is probably no single individual in Environmental Affairs with the requisite knowledge in all areas. The best way I can think of to assure that the regulatory questions are answered is to use the environmental checklist process, where, after you submit an environmental checklist that describes the activity and the direct impacts, we will route it to the appropriate regulatory experts for review and identification of requirements that must be met to conduct the activity.

Appendix C
LMITCO Material Test Lab Physical Characteristics Report

Report on the CPP Coal Fired Facility

Ash Pit Evaluation

1.0 Introduction

The CPP Coal Fired Steam Generator Facility produces a combination of waste ash from four different waste streams as a by-product of the burning of coal and pellets from the CPP Pelletizer. The various waste ash streams are collected in the Ash Silo located adjacent to the facility and becomes partially blended in the Ash Silo prior to being mixed with water and dumped into a waste ash pit located near the facility. The waste ash streams can be quantitatively separated into Spent Bed, Economizer, Bag House and Ash Silo. The Ash Silo portion of the waste ash is, for all practical purposes, a combination of the remaining three waste streams. This Ash Silo is apparently not homogeneous and therefor does not lend itself to representative sampling.

Sampling of these ash streams began in January of this year. Initially, several one gallon metal cans were collected to represent the various ash streams. The first two waste samples taken were of the Spent Bed Ash. The second two samples were of the Ash Pit near the Coal Fired Facility. At the time the first two samples were collected, it was not possible to collect samples from the Economizer or the Bag House ash streams. Plant personnel collected the Economizer and Bag House samples the following week.

The primary purpose of testing these ash mixtures was to determine if the any of the various waste products, either separately or in combination, could be used to produce a viable grout mixture. A secondary purpose of this evaluation was to investigate the possibility that part or all of this waste ash may have some commercial applications.

2.0 Preliminary Mixes

Following the initial meeting with projects, engineering and plant representatives, it was requested of the INEEL Materials Lab to conduct some preliminary testing of the ash samples. These first tests were primarily directed at testing the ash for self-cementing capabilities and reactions with cement. The criteria for the testing of these ash samples is found in the ASTM C 311-90 Test Method for Sampling and Testing Fly Ash or Natural Pozzolans for use as a Mineral Aggregate in Portland Cement Concrete.

The first series of tests conducted on these ash samples involved mixing the ash with water only to form a thin paste to determine if the mixture would self-harden. Almost immediately, it was noted that the samples from the Spent Bed, Economizer and the Ash Silo (combination of ash streams) all reacted quite rapidly with the addition of water to create heat (in excess of 150 – 200 degrees F.) and expansion. These ash mixtures were molded into 2"x2" Cube Molds and kept moist for approximately 24 hours. After the 24-hour period, it was noticed that expansion of these ash mixtures had broken the thumbscrews holding the molds together. Some of these molds were distorted and/or pushed off their respective anchor plates. This expansive reaction, including the giving off of considerable heat, varies with the type of ash sample used. The most reactive of the ash samples is the Spent Bed material, followed closely by the Economizer ash, Ash Silo and finally the Bag House ash. It should be noted at this time that the Bag House ash does not react as rapidly or expand as much as the other ash samples.

After this initial series of mixes, a second set of mixes was conducted on these samples. This second set of tests involved mixing the Spent Bed, Economizer and Ash Silo samples with cement and water. This set of tests used a mixture of 50% cement and 50% ash, with enough water to form a "cake mix" consistency. The various mixtures did not exhibit as much heat or expansion as the water only mixtures, however, the mixes did show many signs of expansion and generated some heat upon hydration (approximately 100 degrees F.).

During this initial testing phase, it was noticed that after the initial addition of water only and subsequent drying of the ash/water mixture, the ash samples from the Spent Bed, Economizer and the combined Ash Silo all changed form and appearance. After the addition of water to the ash samples, they were mixed and dried in an oven at 100 degrees centigrade for at least four hours. During this initial hydration and drying, the samples from the Spent Bed and the Economizer became lighter in color, less coarse in texture and expanded by approximately 1 ½ times their original volume. The samples from the Ash Silo reacted less than the first two mentioned above, but did noticeably change appearance and volume. The Bag House and Ash Pit samples do not indicate a reaction when hydrated.

After this initial hydration and drying for volume and form change, all of the ash samples exhibited no volume expansion or generating of heat in any subsequent mixing with water and/or cement. This indicates that the Ash Pit samples taken from the waste pit near the facility has already undergone this change in chemical structure.

3.0 Final Mixes

After the initial mixes performed in the lab, a second series of tests on the ash samples were conducted to determine if these ash streams could be incorporated into a viable cement/grout mixture. This second set of mixes used only the hydrated ash samples to eliminate expansion problems. To mix these samples of ash consistently, Hobart mixers were used to blend the ash/cement/water mixtures for consistency. Dry ingredients were first mixed for uniformity, water was then added and this combination was initially mixed for five minutes, stopped for two to three minutes, and finally mixed for 5 more minutes. Initial set time and final set time was measured from the time water was first added until Initial and Final Set was achieved using ASTM C-266, (Gillmore Needles).

Mixes were conducted on each of the four main ash types, Spent Bed, Economizer, Bag House and Ash Pit. The first mix was a baseline mixture of cement and water only. Mixes two through five were mixed 50% ash and 50% cement, with enough water to make a mix with a "cake mix" consistency. A set of twelve 2" x 2" cubes were cast from each of the mixes. From these cubes, density, compressive strength and shrinkage/expansion were determined. It should be noted that the ash/cement mixtures from the Spent Bed, Ash Pit and Economizer samples were rather "sandy" or coarse in texture, similar to a cell-fill type of commercial grout mix. The Bag House ash/cement mixture was very similar in texture and appearance to Class C/F fly ash and cement, which is quite smooth and creamy.

A second set of mixes was conducted on the Ash Pit sample and the Bag House sample using a 35% cement/65% ash mixture. Also included in this second set of mixes was two more base-line mixtures using 50% commercial grade class C/F fly ash, 50% cement and 65% commercial grade class C/F fly ash, 35% cement. Due to budgets and time constraints, mix designs incorporating other percentages of fly ash/cement were not conducted at this time.

4.0 Mix Design Results

All of the mixes tested utilized ash samples that have been hydrated and dried prior to testing. This was done to control or eliminate expansion of the ash/cement mixture. The ash samples from the Spent Bed and the Economizer, when hydrated, achieve the same basic characteristics as the Ash Pit material. It appears that the majority of the material in the ash pit waste area is composed of Spent Bed and Economizer ash with Bag House material composing the remainder of the ash. It is also worthy to note at this time that the Ash Pit waste ash has already been hydrated at least once during the process of transporting the combined ash to the waste pit. This should be all that is necessary to assure that the ash, if used in a grout mix, will not be expansive enough to cause any problems, however, a little further testing on expansion/shrinkage should be conducted on different types and sizes of samples to confirm this observation.

Test results of the various mixes were very encouraging. The mixes using 50% ash and the mixes with 65% ash both produced similar results as far as texture, temperature of the mix and ease of blending and/or mixing. As expected, the ash mixes with 65% ash by weight were lower in overall compressive strengths and longer in set times, both initial set and final set.

As is indicated by the test results charted in appendix 1, the ash produced from the Coal Fired facility is lighter in density than commercial fly ash, lighter in overall color and much coarser in texture than commercial fly ash. The Loss on Ignition (LOI) tests indicates that the ash samples from each of the waste streams have a higher loss overall than commercial fly ash. The Bag House ash material is much closer to commercial grade fly ash in areas such as density, texture, and size of particles.

Ash Mix and Type of Ash used.	% Cement used - % Ash used	Temp Rise	Time of Set hrs.	Moisture Content of Ash.	Loss on Ignition (LOI).	Shrinkage %	Specific Gravity
No Ash used Cement only.	100% Cmt 0% Ash	None	0.5 initial 2.0 final	0.5%	Not tested	Shrinkage less than 1%	3.14
Economizer Ash And Cement	50% Cmt. 50% Ash	None	2.5 initial 4.0 final	3.8%	3.6%	Average of 4 cubes 2.2%	2.10
Bag House Ash And Cement	50% Cmt. 50% Ash	None	2.5 initial 5.0 final	0.0%	0.32%	Average of 4 cubes 2.4%	2.11
Spent Bed Ash And Cement	50% Cmt. 50% Ash	None	2.0 initial 4.5 final	1.1%	3.1%	Average of 4 cubes 2.4%	2.02
Ash Pit Ash And Cement	50% Cmt. 50% Ash	None	2.25 initial 4.5 final	3.5%	4.7%	Average of 4 cubes 2.0%	1.95
Bag House Ash And Cement	35% Cmt. 65% Ash	None	4.0 initial 8.0 final	0.2%	0.58%	Average of 4 cubes 2.3%	2.11
Ash Pit Ash And Cement	35% Cmt. 65% Ash	None	4.1 initial 10 final	2.8%	3.8%	Average of 4 cubes 2.1%	1.95
Commercial Fly Ash and Cement	35% Cmt. 65% Ash	None	2.0 initial 3.7 final	0.0%	0.26%	Shrinkage less than 1%	2.46

Ash mix and type of ash used	Compressive Strengths PSI - Days					Sieve Analysis Percent Finer		
	3	7	14	28	42	#4	#200	#325
Cement only No Ash	5175 7225	8363 8475	9950 10,600	11,100 11,625	11,525 11,700	100%	96.4%	83.4%
Bag House Ash with 50% cement	1778 1725	2312 2225	2925 3038	3363 3263	4200 4213	100%	80.0%	63.3%
Bag house Ash with 35% cement	300 394	1013 988	1338 1325	1725 1688	1775 1738	Same	As	Above
Spent Bed Ash with 50% cement	688 675	1138 1175	1463 1375	1838 1863	2263 2300	100%	4.1%	1.1%
Ash Pit Ash with 50% cement	988 950	1563 1438	1900 1975	2013 2000	2037 2062	100%	9.8%	3.5%
Ash Pit Ash with 35% cement	213 263	413 388	638 613	600 588	594 600	Same	As	Above
Economizer Ash with 50% cement	1212 1350	1800 2113	2300 2250	2900 2725	2988 2925	100%	12.4%	4.0%
Commercial Fly Ash with 50% Cmt.	2375 2563	4638 4563	7138 7413	7725 8000	10,200 10,500	100%	90.1%	79.9%
Commercial Fly Ash with 35% cmt.	1950 2113	3075 4563	4850 4863	5300 5150	6100 6025	Same	As	Above

Appendix D
Wyoming Analytical Laboratory Inc. Chemical Test Reports

WYOMING ANALYTICAL LABORATORIES, INC.

1511 Washington Ave.
Golden, CO 80401
e-mail: walxray@aol.com
(303) 278-2446
Fax: (303) 278-2439

March 10, 1998

Rodrigo Ochoa
Lockheed Martin Idaho Tech. Co.
2525 Fremont Ave.
Idaho Falls, ID 83415

Denver Div. # 98123-1
Sample ID: Baghouse Ash CPP-687

CHEMICAL ANALYSIS
WT%, DRY BASIS

Silicon Dioxide, SiO_2	24.39	
Aluminum Oxide, Al_2O_3	4.96	
Iron Oxide, Fe_2O_3	2.00	
Total (SiO_2 + Al_2O_3 + Fe_2O_3)		31.36
Calcium Oxide, CaO	49.35	
Magnesium Oxide, MgO	1.34	
Sodium Oxide, Na_2O	2.21	
Potassium Oxide, K_2O	0.19	
Titanium Dioxide, TiO_2	0.39	
Manganese Dioxide, MnO_2	0.02	
Phosphorus Pentoxide, P_2O_5	0.17	
Strontium Oxide, SrO	0.07	
Barium Oxide, BaO	0.02	
Sulfur Trioxide, SO_3	3.21	
Loss on Ignition	11.68	
Moisture, as Received	0.08	
pH	12.5	

Charles R. Wilson
Division Manager

MEMBER ACIL

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March 10, 1998

Rodrigo Ochoa
Lockheed Martin Idaho Tech. Co.
2525 Fremont Ave.
Idaho Falls, ID 83415

Denver Div. # 98123-2
Sample ID: Spent Bed CPP-687

CHEMICAL ANALYSIS
WT%, DRY BASIS

Silicon Dioxide, SiO2	29.85	
Aluminum Oxide, Al2O3	19.42	
Iron Oxide, Fe2O3	1.10	
Total (SiO2 + Al2O3 + Fe2O3)		50.36
Calcium Oxide, CaO	39.45	
Magnesium Oxide, MgO	0.71	
Sodium Oxide, Na2O	1.20	
Potassium Oxide, K2O	0.13	
Titanium Dioxide, TiO2	0.97	
Manganese Dioxide, MnO2	0.02	
Phosphorus Pentoxide, P2O5	0.14	
Strontium Oxide, SrO	0.09	
Barium Oxide, BaO	0.01	
Sulfur Trioxide, SO3	6.13	
Loss on Ignition	0.78	
Moisture, as Received	0.03	
pH	12.6	

Charles R. Wilson
Division Manager

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March 10, 1998

Rodrigo Ochoa
Lockheed Martin Idaho Tech. Co.
2525 Fremont Ave.
Idaho Falls, ID 83415

Denver Div. # 98123-3
Sample ID: Hydrated Ash Pit Material CPP-687

CHEMICAL ANALYSIS
WT%, DRY BASIS

Silicon Dioxide, SiO2	8.77	
Aluminum Oxide, Al2O3	4.55	
Iron Oxide, Fe2O3	0.63	
Total (SiO2 + Al2O3 + Fe2O3)		13.96
Calcium Oxide, CaO	58.53	
Magnesium Oxide, MgO	0.94	
Sodium Oxide, Na2O	0.50	
Potassium Oxide, K2O	0.08	
Titanium Dioxide, TiO2	0.26	
Manganese Dioxide, MnO2	0.02	
Phosphorus Pentoxide, P2O5	0.09	
Strontium Oxide, SrO	0.04	
Barium Oxide, BaO	0.00	
Sulfur Trioxide, SO3	3.51	
Loss on Ignition	22.08	
Moisture, as Received	0.04	
pH	12.6	

Charles R. Wilson
Division Manager

Wyoming Analytical Laboratories, Inc.

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March 10, 1998

Rodrigo Ochoa
Lockheed Martin Idaho Tech. Co.
2525 Fremont Ave.
Idaho Falls, ID 83415

Denver Div. # 98123-4
Sample ID: Economizer CPP-687

CHEMICAL ANALYSIS
WT%, DRY BASIS

Silicon Dioxide, SiO_2	23.32	
Aluminum Oxide, Al_2O_3	9.52	
Iron Oxide, Fe_2O_3	0.93	
Total (SiO_2 + Al_2O_3 + Fe_2O_3)		33.76
Calcium Oxide, CaO	52.94	
Magnesium Oxide, MgO	1.05	
Sodium Oxide, Na_2O	1.46	
Potassium Oxide, K_2O	0.15	
Titanium Dioxide, TiO_2	0.49	
Manganese Dioxide, MnO_2	0.02	
Phosphorus Pentoxide, P_2O_5	0.13	
Strontium Oxide, SrO	0.06	
Barium Oxide, BaO	0.02	
Sulfur Trioxide, SO_3	2.45	
Loss on Ignition	7.47	
Moisture, as Received	0.00	
pH	12.5	

Charles R. Wilson
Division Manager

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April 2, 1998

Mr. Rodrigo Ochoa
Lockheed Martin Idaho Tech. Co.
2525 Fremont Ave.
Idaho Falls, ID 83415

Re: 98123
P.O. K98-179301
CPP-687

ANALYTICAL REPORT

Trace Elements
mg/kg, Dry Basis

Parameter	Baghouse Ash	Spent Bed	Hydrated Ash Pit Material	Economizer
Beryllium	<0.1	<0.1	<0.1	<0.1
Cadmium	<10	<10	<10	<10
Chromium	12	28	<3	48
Copper	59	53	28	47
Lead	<2	22	13	10
Manganese	27	44	10	22
Nickel	30	26	4	18
Vanadium	44	46	<2	26
Zinc	21	18	7	15

Wt. %, Dry Basis

Parameter	Baghouse Ash	Spent Bed	Hydrated Ash Pit Material	Economizer
Available Lime Index, CaO	33.6	24.3	34.4	28.5
Calcium Carbonate Equivalent, CaCO3	80.8	70.6	105.1	98.1
Total Carbon	4.89	0.39	1.50	1.81

Charles R. Wilson
Laboratory Manager

MEMBER ACIL

WAL

WYOMING ANALYTICAL LABORATORIES, INC.

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Fax: (303) 278-2439

April 8, 1998

Rodrigo Ochoa
Lockheed Martin Idaho Tech. Co.
2525 Fremont Ave.
Idaho Falls, ID 83415

AVAILABLE ALKALIES

SAMPLE ID	Na2O	K2O	Total, as Na2
Baghouse A CPP-687	1.15	0.09	1.21
Economizer CPP-687	0.47	0.06	0.51
Hydrated A Pit Material CPP-687	0.19	0.06	0.23
Spent Bed CPP-687	0.17	0.04	0.20

Charles R. Wilson
Division Manager

Appendix E
Commercial Testing and Engineering Co.
Chemical Test Reports

Ash Sample Legend

Tests 1 & 2	100% Coal/ 0% Paper Pellets
Tests 3 & 4	90% Coal/ 10% Paper Pellets
Tests 5 & 6	80% Coal/ 20% Paper Pellets
Tests 7 & 8	75% Coal/ 25% Paper Pellets

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 708-953-9300 FAX: 708-953-9306

SINCE 1908

SGS Member of the SGS Group (Société Générale de Surveillance)

PLEASE ADDRESS ALL CORRESPONDENCE TO:
4665 PARIS STREET
SUITE B-200
DENVER, CO 80239
TEL: (303) 373-4772
FAX: (303) 373-4791

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340101

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	88	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	3900	mg/L	10	SM2540 C
Sulfate, SO_4	11	mg/L	1	SM4500-SO4 C
pH	12.36	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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TEL: (303) 373-4772
FAX: (303) 373-479-

August 13, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340101

PARAMETER	RESULTS
Silica, SiO_2	28.46
Alumina, Al_2O_3	7.50
Titania, TiO_2	0.69
Ferric Oxide, Fe_2O_3	2.69
Calcium Oxide, CaO	51.19
Magnesium, MgO	1.93
Potassium Oxide, K_2O	0.36
Sodium Oxide, Na_2O	2.65
Sulfur Trioxide, SO_3	3.47
Phosphorus Pentoxide, P_2O_5	0.38
Strontium Oxide, SrO	0.05
Barium Oxide, BaO	0.06
Manganese Oxide, Mn_3O_4	0.01
% Moisture @ 105° (as received)	0.83
% Dry Combustibles	15.38

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340101

PARAMETER	RESULTS
Aluminum, Al	32000
Antimony, Sb	3
Arsenic, As	4
Barium, Ba	330
Cadmium, Cd	<2
Chromium, Cr	23
Cobalt, Co	10
Copper, Cu	33
Lead, Pb	<20
Manganese, Mn	140
Mercury, Hg	0.26
Nickel, Ni	22
Selenium, Se	8
Silver, Ag	2
Thallium, Tl	<4
Tin, Sn	<4
Vanadium, V	24
Zinc, Zn	230

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 8, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340101

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	4.6
Cadmium, Cd	<0.01
Chromium Cr	<0.01
Lead, Pb	<0.05
Mercury, Hg	<0.0002
Selenium, Se	<0.02
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	0.02
Vanadium, V	<0.01
Zinc, Zn	0.04

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340105

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	13	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	3970	mg/L	10	SM2540 C
Sulfate, SO_4	460	mg/L	1	SM4500-SO4 C
pH	12.40	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 13, 1996

CARNOT
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SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340105

PARAMETER	RESULTS
Silica, SiO_2	45.84
Alumina, Al_2O_3	8.80
Titania, TiO_2	0.42
Ferric Oxide, Fe_2O_3	2.79
Calcium Oxide, CaO	33.18
Magnesium, MgO	1.33
Potassium Oxide, K_2O	0.14
Sodium Oxide, Na_2O	3.66
Sulfur Trioxide, SO_3	2.95
Phosphorus Pentoxide, P_2O_5	0.27
Strontium Oxide, SrO	0.04
Barium Oxide, BaO	0.05
Manganese Oxide, Mn_3O_4	0.00
% Moisture @ 105° (as received)	0.39
% Dry Combustibles	15.68

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 708-953-9300 FAX: 708-953-9306
SINCE 1908
SGS Member of the SGS Group (Société Générale de Surveillance)

PLEASE ADDRESS ALL CORRESPONDENCE TO:
4665 PARIS STREET
SUITE B-200
DENVER, CO 80239
TEL: (303) 373-4772
FAX: (303) 373-4791

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340105

PARAMETER	RESULTS
Aluminum, Al	36800
Antimony, Sb	<4
Arsenic, As	4
Barium, Ba	280
Cadmium, Cd	<2
Chromium, Cr	22
Cobalt, Co	8
Copper, Cu	23
Lead, Pb	50
Manganese, Mn	160
Mercury, Hg	0.04
Nickel, Ni	8
Selenium, Se	<4
Silver, Ag	<2
Thallium, Tl	<4
Tin, Sn	<4
Vanadium, V	16
Zinc, Zn	10

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

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FAX: (303) 373-4791

August 8, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 1 & 2
TIME : 1000 - 1800

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 25, 1996

Date received July 11, 1996

Analysis report no. 72-340105

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	0.95
Cadmium, Cd	<0.01
Chromium Cr	<0.01
Lead, Pb	0.11
Mercury, Hg	<0.0002
Selenium, Se	<0.02
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	<0.01
Vanadium, V	<0.01
Zinc, Zn	0.05

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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4665 PARIS STREE
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TEL: (303) 373-47
FAX: (303) 373-47

ugust 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340106

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	27	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	4090	mg/L	10	SM2540 C
Sulfate, SO_4	480	mg/L	1	SM4500-SO4 C
pH	12.31	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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FAX: (303) 373-4791

August 13, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340106

PARAMETER	RESULTS
Silica, SiO_2	53.83
Alumina, Al_2O_3	10.45
Titania, TiO_2	0.54
Ferric Oxide, Fe_2O_3	3.23
Calcium Oxide, CaO	23.01
Magnesium, MgO	1.48
Potassium Oxide, K_2O	0.16
Sodium Oxide, Na_2O	4.58
Sulfur Trioxide, SO_3	2.37
Phosphorus Pentoxide, P_2O_5	0.25
Strontium Oxide, SrO	0.05
Barium Oxide, BaO	0.05
Manganese Oxide, Mn_3O_4	0.00
% Moisture @ 105° (as received)	0.59
% Dry Combustibles	19.75

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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FAX: (303) 373-4791

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340106

PARAMETER	RESULTS
Aluminum, Al	46100
Antimony, Sb	<4
Arsenic, As	<4
Barium, Ba	300
Cadmium, Cd	<2
Chromium, Cr	18
Cobalt, Co	<4
Copper, Cu	28
Lead, Pb	<20
Manganese, Mn	170
Mercury, Hg	0.03
Nickel, Ni	5
Selenium, Se	<4
Silver, Ag	2
Thallium, Tl	<4
Tin, Sn	<4
Vanadium, V	24
Zinc, Zn	32

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
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August 8, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340106

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	0.92
Cadmium, Cd	<0.01
Chromium Cr	<0.01
Lead, Pb	0.08
Mercury, Hg	0.0003
Selenium, Se	<0.02
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	<0.01
Vanadium, V	<0.01
Zinc, Zn	0.02

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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FAX: (303) 373-4791

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340107

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	53	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	3910	mg/L	10	SM2540 C
Sulfate, SO_4	510	mg/L	1	SM4500-SO4 C
pH	12.35	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 13, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340107

PARAMETER	RESULTS
Silica, SiO_2	53.92
Alumina, Al_2O_3	13.68
Titania, TiO_2	0.73
Ferric Oxide, Fe_2O_3	3.55
Calcium Oxide, CaO	18.01
Magnesium, MgO	1.43
Potassium Oxide, K_2O	0.28
Sodium Oxide, Na_2O	3.96
Sulfur Trioxide, SO_3	2.85
Phosphorus Pentoxide, P_2O_5	0.33
Strontium Oxide, SrO	0.06
Barium Oxide, BaO	0.13
Manganese Oxide, Mn_3O_4	0.03
% Moisture @ 105° (as received)	0.75
% Dry Combustibles	19.25

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340107

PARAMETER	RESULTS
Aluminum, Al	57300
Antimony, Sb	<4
Arsenic, As	<4
Barium, Ba	300
Cadmium, Cd	<2
Chromium, Cr	25
Cobalt, Co	10
Copper, Cu	66
Lead, Pb	50
Manganese, Mn	230
Mercury, Hg	0.09
Nickel, Ni	17
Selenium, Se	<4
Silver, Ag	<2
Thallium, Tl	<4
Tin, Sn	<4
Vanadium, V	23
Zinc, Zn	110

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

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August 8, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340107

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	0.90
Cadmium, Cd	<0.01
Chromium Cr	<0.01
Lead, Pb	0.08
Mercury, Hg	<0.0002
Selenium, Se	<0.02
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	0.02
Vanadium, V	<0.01
Zinc, Zn	0.04

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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FAX: (303) 373-4791

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340108

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	68	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	3530	mg/L	10	SM2540 C
Sulfate, SO_4	560	mg/L	1	SM4500-SO4 C
pH	12.28	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 708-953-9300 FAX: 708-953-9306

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August 13, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340108

PARAMETER	RESULTS
Silica, SiO_2	53.56
Alumina, Al_2O_3	14.23
Titania, TiO_2	0.87
Ferric Oxide, Fe_2O_3	3.44
Calcium Oxide, CaO	18.92
Magnesium, MgO	1.39
Potassium Oxide, K_2O	0.35
Sodium Oxide, Na_2O	3.73
Sulfur Trioxide, SO_3	3.11
Phosphorus Pentoxide, P_2O_5	0.30
Strontium Oxide, SrO	0.05
Barium Oxide, BaO	0.00
Manganese Oxide, Mn_3O_4	0.05
% Moisture @ 105° (as received)	1.02
% Dry Combustibles	18.71

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.
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TEL: (303) 373-477?
FAX: (303) 373-479?

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340108

PARAMETER	RESULTS
Aluminum, Al	63900
Antimony, Sb	<4
Arsenic, As	<4
Barium, Ba	320
Cadmium, Cd	<2
Chromium, Cr	29
Cobalt, Co	6
Copper, Cu	110
Lead, Pb	22
Manganese, Mn	280
Mercury, Hg	0.09
Nickel, Ni	<4
Selenium, Se	<4
Silver, Ag	<2
Thallium, Tl	<4
Tin, Sn	11
Vanadium, V	24
Zinc, Zn	190

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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TEL: (303) 373-47
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August 8, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: ECONOMIZER ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340108

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	0.94
Cadmium, Cd	<0.01
Chromium Cr	<0.01
Lead, Pb	0.09
Mercury, Hg	<0.0002
Selenium, Se	<0.02
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	0.02
Vanadium, V	<0.01
Zinc, Zn	0.04

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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4665 PARIS STREET
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TEL: (303) 373-4772
FAX: (303) 373-4791

August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340102

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	38	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	4250	mg/L	10	SM2540 C
Sulfate, SO_4	210	mg/L	1	SM4500-SO4 C
pH	12.40	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted.
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

COMMERCIAL TESTING & ENGINEERING CO.
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SUITE B-200
DENVER, CO 80239
TEL: (303) 373-4772
FAX: (303) 373-4791

August 13, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340102

PARAMETER	RESULTS
Silica, SiO_2	39.43
Alumina, Al_2O_3	9.08
Titania, TiO_2	0.92
Ferric Oxide, Fe_2O_3	4.45
Calcium Oxide, CaO	35.85
Magnesium, MgO	2.17
Potassium Oxide, K_2O	0.22
Sodium Oxide, Na_2O	3.96
Sulfur Trioxide, SO_3	3.45
Phosphorus Pentoxide, P_2O_5	0.35
Strontium Oxide, SrO	0.08
Barium Oxide, BaO	0.00
Manganese Oxide, Mn_3O_4	0.04
% Moisture @ 105° (as received)	0.82
% Dry Combustibles	13.38

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 12, 1996

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15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340102

PARAMETER	RESULTS
Aluminum, Al	38600
Antimony, Sb	<4
Arsenic, As	<4
Barium, Ba	620
Cadmium, Cd	<2
Chromium, Cr	44
Cobalt, Co	11
Copper, Cu	44
Lead, Pb	<20
Manganese, Mn	240
Mercury, Hg	0.26
Nickel, Ni	12
Selenium, Se	15
Silver, Ag	2
Thallium, Tl	<4
Tin, Sn	<4
Vanadium, V	48
Zinc, Zn	35

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

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August 8, 1996

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Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 3 & 4
TIME : 0900 - 1700

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 26, 1996

Date received July 11, 1996

Analysis report no. 72-340102

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	2.1
Cadmium, Cd	<0.01
Chromium Cr	<0.01
Lead, Pb	<0.05
Mercury, Hg	<0.0002
Selenium, Se	0.03
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	<0.01
Vanadium, V	0.03
Zinc, Zn	0.03

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340103

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	75	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	3470	mg/L	10	SM2540 C
Sulfate, SO_4	240	mg/L	1	SM4500-SO4 C
pH	12.25	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
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SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340103

PARAMETER	RESULTS
Silica, SiO_2	40.41
Alumina, Al_2O_3	9.41
Titania, TiO_2	1.06
Ferric Oxide, Fe_2O_3	5.30
Calcium Oxide, CaO	30.97
Magnesium, MgO	2.36
Potassium Oxide, K_2O	0.30
Sodium Oxide, Na_2O	4.29
Sulfur Trioxide, SO_3	4.35
Phosphorus Pentoxide, P_2O_5	0.38
Strontium Oxide, SrO	0.09
Barium Oxide, BaO	0.10
Manganese Oxide, Mn_3O_4	0.05
% Moisture @ 105° (as received)	0.88
% Dry Combustibles	11.37

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

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Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340103

PARAMETER	RESULTS
Aluminum, Al	45000
Antimony, Sb	<4
Arsenic, As	<4
Barium, Ba	650
Cadmium, Cd	<2
Chromium, Cr	56
Cobalt, Co	11
Copper, Cu	52
Lead, Pb	53
Manganese, Mn	300
Mercury, Hg	0.36
Nickel, Ni	11
Selenium, Se	20
Silver, Ag	<2
Thallium, Tl	<4
Tin, Sn	5
Vanadium, V	70
Zinc, Zn	78

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

Respectfully submitted,
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Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 5 & 6
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 27, 1996

Date received July 11, 1996

Analysis report no. 72-340103

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	1.7
Cadmium, Cd	<0.01
Chromium Cr	0.01
Lead, Pb	0.10
Mercury, Hg	<0.0002
Selenium, Se	0.05
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	0.04
Vanadium, V	<0.01
Zinc, Zn	0.04

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

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August 12, 1996

CARNOT
15991 RED HILL AVENUE
SUITE 110
TUSTIN CA 92680

Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340104

PARAMETER	RESULTS	UNITS	DETECTION LIMIT	METHOD
Chloride, Cl	153	mg/L	1	SM4500-CL E
Total Dissolved Solids, TDS	3450	mg/L	10	SM2540 C
Sulfate, SO_4	200	mg/L	1	SM4500-SO4 C
pH	12.32	s.u.	0.01	SM4500 H

Results: Results are reported as indicated, on an Extract basis.

Respectfully submitted,
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Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340104

PARAMETER	RESULTS
Silica, SiO_2	45.27
Alumina, Al_2O_3	12.02
Titania, TiO_2	1.30
Ferric Oxide, Fe_2O_3	4.51
Calcium Oxide, CaO	25.61
Magnesium, MgO	2.06
Potassium Oxide, K_2O	0.41
Sodium Oxide, Na_2O	4.05
Sulfur Trioxide, SO_3	4.16
Phosphorus Pentoxide, P_2O_5	0.41
Strontium Oxide, SrO	0.07
Barium Oxide, BaO	0.08
Manganese Oxide, Mn_3O_4	0.03
% Moisture @ 105° (as received)	0.96
% Dry Combustibles	12.20

Procedure: Mineral Analysis per ASTM, Part 05.05, Method D4326-84.

Results: Mineral Analysis results are reported in weight percent (Wt. %), on an ignited basis.

Respectfully submitted,
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SUITE 110
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Sample identification by
CARNOT

SAMPLE ID: BAGHOUSE ASH SAMPLES
TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340104

PARAMETER	RESULTS
Aluminum, Al	57100
Antimony, Sb	10
Arsenic, As	6
Barium, Ba	570
Cadmium, Cd	<2
Chromium, Cr	61
Cobalt, Co	21
Copper, Cu	84
Lead, Pb	98
Manganese, Mn	300
Mercury, Hg	0.39
Nickel, Ni	21
Selenium, Se	14
Silver, Ag	<2
Thallium, Tl	<4
Tin, Sn	12
Vanadium, V	59
Zinc, Zn	200

Procedure: The sample was prepared according to ASTM, Part 05.05, Method D 3683. The sample was analyzed for trace elements by Inductively Coupled Plasma Emission Spectroscopy.

Antimony, Arsenic, Selenium, Tin and Thallium are determined by Graphite Furnace Atomic Absorption.

Mercury was determined by Double Gold Amalgamation Cold Vapor Atomic Absorption.

Results: Results are reported in micrograms per gram (ug/g), on a dry basis.

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TEST #: 7 & 8
TIME : 0800 - 1600

Kind of sample ASH

Sample taken at ARGONNE

Sample taken by CARNOT

Date sampled June 28, 1996

Date received July 11, 1996

Analysis report no. 72-340104

TCLP EXTRACT ELEMENTS

Arsenic, As	<0.02
Barium, Ba	1.9
Cadmium, Cd	<0.01
Chromium Cr	0.02
Lead, Pb	0.08
Mercury, Hg	0.0002
Selenium, Se	0.03
Silver, Ag	<0.01
Beryllium, Be	<0.01
Nickel, Ni	<0.01
Vanadium, V	<0.01
Zinc, Zn	0.03

Procedure: TCLP per EPA Reference SW-846, Method 1311.

Results: TCLP results are reported in milligrams per liter, (mg/L), on an extract basis.

Respectfully submitted.
COMMERCIAL TESTING & ENGINEERING CO.

Denver Laboratory

Appendix F
ASTM D5759 Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses

Designation: D 5759 – 95

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St. Philadelphia, Pa 19103
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If not listed in the current combined index, will appear in the next edition.

Standard Guide for Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses[1]

This standard is issued under the fixed designation D 5759; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide recommends standards for the characterization of fly ash from the combustion of coal, fly ash from coal combusted in the presence of alkaline materials, and fly ash from combusted coal in which the flue gases have been treated with alkaline materials in the presence of the fly ash.

1.2 This guide provides recommended and optional test methods for fly ash evaluation. Acceptance criteria can be negotiated between the producer and the user according to the potential end use.

1.3 The coal fly ash and clean coal combustion fly ash of this guide do not include the following:

1.3.1 Dusts from kilns producing products such as lime, portland cement, activated clays, etc.;

1.3.2 By-products of flue gas desulflurization that are not collected with the primary fly ash removal equipment such as the baghouse or electrostatic precipitator; and

1.3.3 Fly ash or other combustion products derived from the burning of waste; municipal, industrial, or commercial garbage; sewage sludge or other refuse, or both; derived fuels; wood; wood waste products; rice hulls; agriculture waste; or other non-coal fuels or other such fuels blended with coal, or some combination thereof.

1.4 Fly ash may contain some trace elements that may affect performance or potential end use.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 22 Specification for Gypsum[2]
C 25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime[2]
C 51 Terminology Relating to Lime and Limestone (As Used by the Industry)[2]
C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)[2]
C 110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone[2]
C 114 Test Methods for Chemical Analysis of Hydraulic Cement[2]
C 150 Specification for Portland Cement[2]
C 191 Test Method for Time of Setting of Hydraulic Cement by Vicat Needle[2]
C 311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete[3]
C 400 Test Method for Testing Quicklime and Hydrated Lime for Neutralization of Waste Acid[2]
C 593 Specification for Fly Ash and Other Pozzolans for Use with Lime[2]
C 595 Specification for Blended Hydraulic Cements[2]
C 602 Specification for Agricultural Liming Materials[2]
C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete[3]
D 546 Test Method for Sieve Analysis of Mineral Filler for Road and Paving Materials[4]
D 1973 Guide for Design of a Linear System for Containment of Wastes[5]
D 2795 Method for Analysis of Coal and Coke Ash[6]
D 3178 Test Method for Carbon and Hydrogen in the Analysis Sample of Coal and Coke[6]
D 3682 Test Method for Major and Minor Elements in Coal and Coke Ash by the Atomic Absorption Method[6]
D 3683 Test Method for Trace Elements in Coal and Coke Ash by the Atomic Absorption Method[6]
D 4326 Test Method for Major and Minor Elements in Coal and Coke by X-Ray Fluorescence[6]
D 5239 Practice for Characterizing Fly Ash for Use in Soil Stabilization[7]
E 1266 Practice for Processing Mixtures of Lime, Fly Ash, and Heavy Metal Wastes in Structural Fills and Other Construction Applications[5]

2.2 *Other Document:*

USEPA Method 9100-SW846 Falling Head or Constand Head[8]

[1] This guide is under the jurisdiction of ASTM Committee D-34 on Waste Management and is the direct responsibility of Subcommittee D34.09 on Treatment.

Current edition approved July 15, 1995. Published September 1995.

[2] *Annual Book of ASTM Standards*, Vol 04.01.

[3] *Annual Book of ASTM Standards*, Vol 04.02.

[4] *Annual Book of ASTM Standards*, Vol 04.03.

[5] *Annual Book of ASTM Standards*, Vol 11.04.

[6] *Annual Book of ASTM Standards*, Vol 05.05.

[7] *Annual Book of ASTM Standards*, Vol 04.09.

[8] Available from Standardization Documents Order Desk, Bldg 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS

3. Terminology

3.1 *Definitions:*

3.1.1 *clean coal combustion*—the burning of coal, coal culm, or coal fines in a furnace designed to operate to minimize emissions (that is, a fluidized bed or aerated fluidized bed, etc.) or coal burned in the presence of alkaline materials, which combine to reduce these emissions.

3.1.2 *fly ash, n*—residual material that exits a combustion chamber in the flue gas.

4. Significance and Use

4.1 This guide provides guidance for the characterization of coal fly ash or clean coal combustion fly ash for potential uses in which absorption, cementitious activity, pozzolanic activity, pH adjustment, heat rise, or stabilization and solidification properties may be desired.

5. Chemical Composition

5.1 Fly ash from coal and clean coal combustion can be characterized by the recommended chemical tests of Table 1 and may be characterized further by the optional chemical tests of Table 2. Limits may be specified by the purchaser if required for a specific application. The most recent limits established by the appropriate regulatory agency shall govern if no specific parameters are required. See Appendix X1 for possible nonmandatory information for various end uses of fly ash.

6. Physical Tests

6.1 Fly ash from coal and clean coal combustion can be tested further in accordance with the optional physical tests of Table 3, if required by the purchaser.

7. Shipments for Delivery to Purchaser

7.1 Fly ash shipped for delivery to the purchaser should be from a single combustion unit or a blend from multiple combustion units, as agreed upon between the purchaser and the supplier, such that the delivered fly ash complies with the provisions of Sections 8 and 9 herein.

8. Sampling and Testing

8.1 Take individual, representative samples of at least 0.5 lb (227 g) from each 100 tons (100 Mg) of fly ash delivered to the purchaser.

8.2 Samples are composites of 0.5-lb (227-g) individual samples of fly ash taken from each 100 tons (100 Mg) shipped. The minimum composite sample size should not be less than 8 lb (3.6 kg). Composites are to consist of nearly equal amounts from individual samples and be mixed thoroughly.

8.2.1 If insufficient fly ash has been shipped to comply with the composite sample requirements as listed in this section, an individual sample, or samples, may be used if agreed upon between the purchaser and the supplier. These samples should be at least 1 lb (454 g) and may represent less than 100 tons (100 Mg) shipped.

8.3 The recommended tests of Table 1 are performed on a sample of at least 1 lb (454 g) composited of individual shipment samples, at a frequency no less than semiannual when at least 100 tons (100 Mg) of fly ash have been shipped to a purchaser.

8.4 For limits as required by the purchaser from Tables 2 and 3, optional tests may be performed on the following frequency unless otherwise agreed upon between the supplier and the purchaser prior to shipment:

8.4.1 Every 2000 tons (2000 Mg) shipped,

8.4.2 A calendar month during which at least 100 tons

TABLE 1 Recommended Chemical Tests

Test Method	Component(s)	Limit[A]
C 114	sulfur trioxide (SO_3), %[B]	
C 311	moisture content, %	
C 311	loss on ignition, %	
D 2795, D 3682, or D 4326	calcium oxide (CaO), %	
D 2795, D 3682, or D 4326	magnesium oxide (MgO), %	
D 2795, D 3682, or D 4326	silicon dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3), %	

[A] On specific projects, a minimum or maximum may be applicable.
[B] Fly ash replaces hydraulic cement in method.

TABLE 2 Optional Chemical Tests[A] (Limits to be Specified Only If Applicable, by the Purchaser)

Test Method	Component(s)	Limit[B]
C 25	available lime index (ALI), %[C]	
C 311	available alkalies as Na_2O, %	
C 400	pH[D]	
C 602	calcium carbonate equivalent ($CaCO_3$), %	
D 3178	carbon (C), %	
D 3683	trace elements (totals) (for example, sulfide, sulfite, and sulfate)	

[A] Individual requirements may be specified by the purchaser if applicable to the project for which fly ash is to be used.
[B] On specific projects, a minimum or maximum may be applicable.
[C] Fly ash replaces limestone in analysis.
[D] Fly ash replaces quicklime in method.

TABLE 3 Optional Physical Tests[A] (To be Specified Only as Required by the Purchaser)

Test Method	Component(s)
C 109	compressive strength of hydraulic cement mortars, psi[B]
C 110	heat rise (slaking rate), °C[C]
C 191	time of set, min[B]
C 311	amount retained on No. 325 sieve, %
C 311	strength activity index with portland cement
	7 days, % of control
	28 days, % of control
C 311	water requirement, % of control[D]
C 311	specific gravity
C 311	increase in drying shrinkage, %
C 311	reactivity with cement alkalies, mortar expansion, % of control
C 311	soundness
C 593	amount retained on No. 200 sieve, %
C 593	amount retained on No. 30 sieve, %
C 593	lime pozzolan strength 7 days, psi
	lime pozzolan strength 28 days, psi
USEPA Method 9100-SW846	

[A] Individual requirements may be specified by the purchaser if applicable to the project for which fly ash is to be used.
[B] Modification of Test Method C 109 to approximate proportion(s) of fly ash instead of cement; or fly ash in combination with other materials to be used on the project (that is, cement, lime, etc.) should be used.
[C] Modify Test Methods C 110 to a proportion of fly ash instead of lime. The fly ash to water ratio may need to be modified further to obtain measurable results.
[D] Comparisons of water requirements to a control material, used at an equal flow, may be useful to determine the relative water requirement.

(100 Mg) of fly ash have been shipped to a purchaser.

9. Test Method

9.1 Testing is conducted in accordance with the appropriate sections of the ASTM standards, or noted modifications, indicated in Table 1, the optional Tables 2 and 3, and the nonmandatory information of Appendix X1, as specified by the purchaser. Individual tests may be selected from Tables 2 and 3 and Appendix X1 according to the need of the user.

10. Inspection and Rejection

10.1 Upon agreement with the supplier, the purchaser should establish the criteria for inspection and testing. The criteria for rejection should be based on the ability of the material to comply with the appropriate specifications as referenced by the purchaser.

11. Compliance and Certification

11.1 Fly ash sampling and testing pursuant to Section 8 may be performed as the fly ash is produced or shipped, or both. Certification of compliance should be provided by the supplier with shipments of fly ash shipped from the production site, at the purchaser's request. If requested by the purchaser, test results on samples of the fly ash shipped should be sent to the purchaser as soon as they are available.

12. Retention of Test Samples

12.1 Samples shall be retained in airtight containers. Sample retention times are permissible if agreed upon between the purchaser and the supplier prior to shipment.

12.2 It is suggested that test data records should be maintained for a period of three years.

13. Keywords

13.1 characterization of clean coal combustion fly ash; characterization of clean coal fly ash; characterization of coal fly ash; fly ash for potential use

APPENDIX

(Nonmandatory Information)

X1. POTENTIAL END USE

TABLE X1.1 Potential End Use[A]

Suggested Referenced Documents	Waste Treatment	Hazard Waste Treatment	Soil Amendment	Soil Stabilalization	Mineral Filler	Pozzolanic Liners	Slurry Wall	Cement Product	Concrete Product	Gypsum Product
USEPA Method 9100-SW846						X	X			
Specification C 22			X			X		X		X
Test Methods C 25	X	X								
Test Method C 109	X	X				X	X		X	
Test Methods C 110	X	X			X	X				
Test Methods C 114	X	X	X	X				X		
Specification C 150								X		
Test Method C 191							X		X	
Test Methods C 311					X	X			X	
Test Method C 400	X	X	X							
Specification C 593						X				
Specification C 595								X		
Specification C 602			X							
Specification C 618									X	
Test Method D 546					X					
Guide D 1973						X				
Method D 2795	X	X						X		
Test Method D 3178								X		
Test Method D 3683	X	X						X		
Practice D 5239				X						
Practice E 1266	X	X				X				

[A] The use of this table is meant to assist the purchaser in selecting applicable best procedures for a specified end use. It is suggestive only.

[B] Suggested documents are to assist in characterizing fly ash as a substitute for the subject materials of those documents.

Appendix G
LMITCO Cost Estimate

LOCKHEED MARTIN

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date:	May 30,1998		
To:	T. A. Langenwalter	MS 3650	6-3320
From:	T. E. Sivill	MS 3655	6-9273
Subject:	ICPP ASH PIT WASTE ALTERNATIVE STUDY – TES-3-98		

Cost Estimating has prepared a Project Support Estimate for the above mentioned project. Unit cost information has been presented on detail sheets, following the format outlined in the alternative study report.

Preliminary scoping information was discussed with cognizant engineers to form the basis of the estimate. Cost information was extrapolated from projects similar in nature, as well as historical data and vendor quotes. All costs have been presented in current year FY 1998 dollars. Assumptions, relating to the basis of the estimate, have been included on the attached Recapitulation Sheet.

Should you have any questions, please feel free to contact Terry Sivill, OV ID-TES, phone, 526-9273.

tes

Attachments

Cc: Estimate File 2377-A
M. C. Pettet MS 3650

Lockheed Martin Idaho Technologies Company

COST ESTIMATE SUPPORT DATA RECAPITUATION

Project Title: ICPP ASH PIT WASTE ALTERNATIVE STUDY

Estimator: T. E. SIVILL
File: 2377-A

Date: 4/30/98
Approved by: [signature]

I. SCOPE OF WORK: *Brief description of the proposed project.*

The ash pit at ICPP currently being used for disposal of fly ash from the ICPP Coal Fired Boiler Plant is near full capacity. A Conceptual Design has been performed for an additional disposal pit at ICPP. The alternative study proposes potential recycling/reuse of the ash in lieu of disposal. Details of how the ash material would be mined from the pit or taken directly from the boiler plant system, to date, have not been designed.

Unit costs were developed targeting ash removal directly from the boiler plant system and retrieval from the existing ash pit. A single cost scenario was developed with the engineering team to establish a benchmark for further project development. A number of other possible alternatives were discussed and may be addressed pending at a later date based on future study.

II. BASIS OF THE ESTIMATE: *Drawings, Design Report, Engineers Notes and/or other documentation upon which the estimate is originated.*

Scope and costs were coordinated with the cognizant engineers at a preliminary planning stage.

Planning Cost Estimate File 2333-A, Coal Fired Steam Boiler Facility Inert Bed Material System, dated 5/12/96.

III. ASSUMPTIONS: *Conditions statements accepted or supposed true without proof of demonstration. An assumption has a direct impact on total estimated cost.*

The following assumptions were developed for the ash removal directly from the boiler plant system.

- A 1200 cf bulk storage silo will be located next to the existing limestone silo on the south side of the main boiler plant.
- Cost allowances for ash material pneumatic feed pumps, piping systems, electrical power and controls were derived from a previous CPP boiler plant upgrade estimate.
- An ash blender/mixer has been included based on engineering input and vendor quote. An allowance was made for installation of the equipment and for existing system modifications required based on minimal information.
- Percentages were for Title Design, Title III Inspection, PM/CM, and LMITCO adders based on INEEL historical data.

IV. **ASSUMPTIONS:** *Conditions statements accepted or supposed true without proof of demonstration. An assumption has a direct impact on total estimated cost.*

The following assumptions were developed for the ash removal from the existing ash disposal pit.

- A new ½ mile long by 10 ft wide gravel equipment access road was to the existing pit.
- For unit costing purposes a one month campaign was assumed as a typical duration for retrieval. Excavation and processing rates for the one month campaign are assumed at 50 tons/day or 74 cy/day. Should excavation and processing demand become a full production retrieval excavation and processing could be significantly increased.
- Equipment utilized for retrieval and processing were leased and purchased as outlined below:
  - Excavator was leased from the CFA Equipment Pool
  - Ash processing equipment included a vibrating grizzly feeder, jaw crusher, and discharge conveyance system to transport truck. This equipment was not readily available for lease at INEEL and was assumed purchased.
  - Transport vehicles is assumed to be a 12 cy lined dump truck. This estimate assumes transport of material is within the ICPP area only. No mileage costs have been included for offsite transport.
- The operations crew are assumed all onsite LMITCO personnel. An average size crew of (6) fte's was developed for costing purposes made up of the following:
  - (1)Excavator operator
  - (1)Laborer/Spotter
  - (2)Processing Equipment Operators
  - (1)Teamster/Supervisor
  - (1)Safety/Quality Engineer

Removal of soil overburden/cover, unique separation of fines material, or additional treatment systems specific end users have not been scoped or costed at this time.

Listed below are other miscellaneous costs presented randomly on the detail sheets as additional engineering information only.

- Cost of purchase of semi/tractor and trailer with tarp cover based on a vendor quote.
- Average cost of commercial grade fly ash is $45/ton. Costs are based on ash material delivered to local concrete subcontractors. Material is primarily purchased from the Jim Bridger Power Plant in Rock Springs Wyoming. Other coal fired plant sources exist in Utah and Oregon.
- One potential end use of the material was a slurry mix for a spray application. Costs for rental equipment and operations were included.

V. **CONTINGENCY GUIDELINE IMPLEMENTATION:** *The percentage used for contingency as determined by the contingency allowance guidelines can be altered to reflect the type of construction and conditions that may impact the total estimated cost.*

Typical Planning Estimates include a contingency range of 20% to 30%. The alternative study does not include the scoping information required for a planning estimate. A contingency analysis was not requested for this study, however was included as a separate line item at 30%.

V. **OTHER COMMENTS/CONCERNS SPECIFIC TO THE ESTIMATE**

Costs were developed on a single scenario as a benchmark for further recycling evaluation. A number of potential applications were discussed but lacked definition for costing. Each customer will have specific requirements defining the ash process needed. As the scope becomes further defined costs shall be reviewed and adjusted.

Lockheed Idaho Technologies Co.

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DETAILED COST ESTIMATE SHEET

Project: ICPP FLY ASH MANAGEMENT

Location: INEEL - ICPP

Requester: T. A. LANGENWALTER

Type of Est.: Project Support

Source: (E) Eng. Est. (V) Vendor (P) Pur. Order (H) Handbook Ref.

File No.: 2377-A

Date: 04/30/98

Prep'd By: T. E. Sivill

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	Ash Silo Collection and Separation System Including: 1200cf, 50 ton silo located next to the limestone silo on the south side of the main boiler plant.										
	Costs include: Silo foundation, silo (as mentioned above), ash conveyance system/collection system with an allowance for piping, valves, rotary position displacement pumps, and controls. Allowances were										
	also made for tie-in modifications to existing systems and additional electrical power forconveyance pumps.										
	Costs were derived parametrically from Planning Estimate 2333-A, dated 5/12/98.										
	ENGINEERING DESIGN AND INSPECTION										152,200
	Design Engineering Title I & II @ 25%		1 ls	148,750					148,750		
	Title III Inspection @ 3%		1 ls	3,450					3,450		
	MANAGEMENT COSTS										118,698
	Project Management @ 10%		1 ls	3,987					3,987		
	Construction Management @ 15%		1 ls	114,711					114,711		
	CONSTRUCTION										
	Silo and Piping System		1 ls	400,000					400,000		400,000
	Blending System		1 ls	98,000	160	160	450	72,000	98,000		170,000
	System Mod's. and Electrical Hookup Allowance		1 ls	25,000					25,000		25,000
	Construction Subcontract Subtotal Directs and Indirect										595,000
	G&A Adder		1 ls	115,000					115,000		115,000
	Material Handling/Procurement Fee @ 2.5%		1 ls	14,875					14,875		14,875
	Construction Subcontract Subtotal										724,875
	PIF @ 5.5%		1 ls	39,868					39,868		39,868
	Construction Subcontract Total										764,743
	PROJECT SUBTOTAL										1,035,641
	Contingency at 30%		1 ls	310,692					310,692		310,692
	TOTAL COST										1,346,334

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. Project Support File No. 2377-A Date 04/30/98

Project ICPP FLY ASH MANAGEMENT

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	Ash Pit Egress										
	Costs include: New Gravel Road Egress assumed 1/2 mile long x 10 ft wide.										
	Costs were derived parametrically from Historical Data										
	ENGINEERING DESIGN AND INSPECTION										6,828
	Design Engineering Title I & II @ 10%		1 ls	6,600					6,600		
	Title III Inspection @ 1.5%		1 ls	228					228		
	MANAGEMENT COSTS										8,966
	Project Management @ 5%		1 ls	228					228		
	Construction Management @ 10%		1 ls	8,739					8,739		
	CONSTRUCTION										
	Construction Subcontract or Lease Option										
	Roadway 2,640 lf x 10 ft wide		26,400 sf	2.5					66,000		66,000
	Construction Subcontract Subtotal Directs and Indirect										66,000
	G&A Adder		1 ls	15,180					15,180		15,180
	Material Handling/Procurement Fee @ 2.5%		1 ls	1,650					1,650		1,650
	Construction Subcontract Subtotal										82,830
	PIF @ 5.5%		1 ls	4,556					4,556		4,556
	Construction Subcontract Total										87,386
	PROJECT SUBTOTAL										103,180
	Contingency at 20%		1 ls	20,636					20,636		20,636
	TOTAL COST										123,816

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. Project Support   File No. 2377-A   Date 04/30/98

Project ICPP FLY ASH MANAGEMENT

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	Ash Pit : Excavation and Processing of Pit Material										
	Costs Include: Lease Excavator from CFA Equipment Pool, purchase Vibrating Grizzly Feeder, Material Jaw Crusher, Discharge Conveyor for Truck Load.										
	Costs assume a one month (20 day) campaign at a rate of 50 tons/day or 75 cy/day = 1,000 tons/mth or 1500 cy/mth. (Material is assumed at 50 lbs/cf or 1,350 lbs/cy)										
	ENGINEERING DESIGN AND INSPECTION										107,800
	Design Engineering Equipment Procurement @ 10%		1 ls	7,800					7,800		
	Permitting and Documentation		1 ls	100,000					100,000		
	MANAGEMENT COSTS										10,597
	Project Management @ 5%		1 ls	269					269		
	Construction Management @ 10%		1 ls	10,327					10,327		
	EQUIPMENT PROCUREMENT										
	46" x 16' Vibrating Grizzly Feeder		1 ls	20,000					20,000		20,000
	10' x 40" Jaw Crusher		1 ls	30,000					30,000		30,000
	24" x 30' Section Discharge Conveyor		1 ls	8,000					8,000		8,000
	Electrical Hookup Allowance		1 ls	20,000					20,000		20,000
	Construction Subcontract Subtotal Directs and Indirect										78,000
	G&A Adder		1 ls	17,940					17,940		17,940
	Material Handling/Procurement Fee @ 2.5%		1 ls	1,950					1,950		1,950
	Construction Subcontract Subtotal										97,890
	PIF @ 5.5%		1 ls	5,384					5,384		5,384
	Construction Subcontract Total										103,274
	Lease of Excavator From Equipment Pool		20 days	1,675					33,500		33,500
	LMITCO Operations-(6) FTE Crew for 20 days		6 fte		160	960	55	52,800			52,800
	PROJECT SUBTOTAL										307,971
	Contingency at 20%		1 ls	61,594					61,594		61,594
	TOTAL COST										369,565

DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. Project Support File No. 2377-A Date 04/30/98

Project ICPP FLY ASH MANAGEMENT

ACCT. NO.	DESCRIPTION	E.V, P.H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	Ash Pit : Transport of Excavated and Processed Pit Material										
	Costs Include: Lease of Lined Dump Truck and Driver for a One Month Campaign										
	Costs assume a one month (20 day) campaign at a rate of 50 tons/day or 75 cy/day = 1,000 tons or 1500 cy/mth										
	Dump Truck with Driver		2 ea		160	320	65	20,800			20,800
	Costs Include: Purchase of Semi Tractor and Front Dump Trailer with Tarp Cover										
	Semi Tractor with Trailer		1 ls	100,000					100,000		100,000

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DETAILED COST ESTIMATE (CONT.SHEET)

Type of Est. Project Support   File No. 2377-A   Date 04/30/98

Project ICPP FLY ASH MANAGEMENT

ACCT. NO.	DESCRIPTION	E,V, P,H	MAT'L UNIT	MAT'L UT. COST	UNIT LAB. HRS	TOTAL LAB. HRS.	LABOR RATE	LABOR COST	MAT'L COST	OTHER COST	TOTAL COST
	End User: Landfill Day Cover Mixing/Spraying Equipment										
	Costs Include: Lease of Mixing/Spraying Equipment, Training of Operators and Operations for a One Month Campaign										
	Costs assume a one month (20 day) campaign										
	ENGINEERING DESIGN AND INSPECTION										5,038
	Design Procurement of Lease Equipmentl @ 10%		1 ls	4,870					4,870		
	Title III Inspection @ 1.5%		1 ls	168					168		
	MANAGEMENT COSTS										6,616
	Project Management @ 5%		1 ls	168					168		
	Construction Management @ 10%		1 ls	6,448					6,448		
	CONSTRUCTION										
	Lease of Mixing and Spraying Equipment		1 mth	7,500					7,500		7,500
	Mobilization and Demobilization of Equipment		1 ls	10,000					10,000		10,000
	Operating Crew		3 fte		160	480	65	31,200			31,200
	Construction Subcontract Subtotal Directs and Indirect										48,700
	G&A Adder		1 ls	11,201					11,201		11,201
	Material Handling/Procurement Fee @ 2.5%		1 ls	1,218					1,218		1,218
	Construction Subcontract Subtotal										61,119
	PIF @ 5.5%		1 ls	3,362					3,362		3,362
	Construction Subcontract Total										64,480
	PROJECT SUBTOTAL										76,134
	Contingency at 20%		1 ls	15,227					15,227		15,227
	TOTAL COST										91,361