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Proposed joint research program: environmental assessment of coal ash leaching properties and beneficial use applications using LEAF

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Abstract

The overall goals of the proposed research are to: (i) increase familiarity and efficiency in use of EPA Leaching Environmental Assessment Framework (LEAF) test methods and interpretation approaches, along with use of LeachXS as a data management and evaluation tool, (ii) develop a LeachXS database of all evaluation results from testing of Israeli coal ash samples and ash derived products, along with comparative information from other sources, (iii) evaluate the effect of high fly ash use rates in concrete and cementitious materials to understand the upper bounds to potential usage rates, and (iv) evaluate the potential for agricultural use of fly ash (and fly ash-containing products) based on testing results from Israeli reference soils and ashes.

For implementing LeachXS Database for management of Israeli materials results, training and assistance will be provided by David Kosson to GSI, Volcani and NCAB staff. Publically available data from earlier studies by US EPA and ECN[1] (and others, if available) will be included in the database as individual data sets and statistical representations to provide a basis for comparison. The resulting database will (i) provide a foundation for on-going data management and evaluation by GSI, including future test results (e.g., from biannual testing), (ii) a context for comparison and quality control of testing in Israel.

GSI has recently completed monolith testing on samples of two cementitious materials formulations, grout and CLSM, prepared with fly ash and analogous samples prepared without fly ash (experimental control samples). The effects of partial carbonation during open air curing on leaching from the materials are uncertain without further evaluation. Furthermore, the fly ash usage rates in these materials appears to be higher than for materials previously tested by others, and as a result, the further analysis of these materials may provide important contributions to the overall understanding of the effects of fly ash usage rates on the leaching of constituents of potential concern (COPCs) from cementitious materials.

Furthermore, it is important to understand the fly ash to cement ratio at which the resulting chemistry shifts from being controlled by the cement chemistry to being controlled by the fly ash chemistry (hereafter referred to as the "tipping point"). We

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propose to carry out formulations of various cement ratios anticipated to bracket the tipping point, with different fly ashes. Following a period of 6 months curing, testing samples will be prepared from the cast materials to carry out pH dependent leaching (Method 1313) and monolith leaching (Method 1315). Results from these tests will be used to select two cases (one above and one below the tipping point) for accelerated aging and testing aged samples using Method 1313 and 1315 along with a percolation column approach (Method 1314). Results from these studies would be used to establish a maximum fly ash content allowed for use in cementitious materials applications.

Evaluation of agricultural use of fly ash is an important goal of this collaboration. The proposed research would consider amending fly ash to agricultural soils at the maximum usage rates suggested in proposed draft Israeli environmental regulations (see http://www.coal-ash.co.il/english/flyashback.html). While the draft regulations focus on boron, the potential impact of other COPCs also should be considered. One fly ash sample and one N-Viro Soil (NVS) sample (Shafdan biosolids stabilized with this fly ash and lime) will be chosen to serve as reference materials that are representative of higher levels of leachable COPCs. In addition, 3 soils will be chosen to serve as reference soils that are representative of Israeli agricultural soil types where NVS application is practiced. Each of the reference materials (fly ash, NVS and soils) as well as fly ash and NVS mixtures with the soils will be tested using EPA Method 1313 (pH dependent leaching) and EPA Method 1314 (upflow column testing). The results of these tests will be used to create a chemical speciation model for the individual materials and blended materials. Column testing also will be carried out using regular and extended length columns to evaluate flow first through soil amended with fly ash and then flow through soil without fly ash. This will allow experimental evaluation of COPCs retention by soil underlying the agricultural application zone and comparison with simulation results.

Stable isotope analysis will also be evaluated as a potential tool for determining the mechanism of leached COPCs of combined coal fly ash applications. Boron, molybdenum and selenium which appear in considerable amounts in the leachates will be considered as potential candidates for this analysis after screening potential contributions from the reference materials. Although concentrations of lead are very low, it is a well-known system and worth considering.

Parallel to these leaching tests, plant uptake studies on the same test cases will be performed using micro-lysimeters following known procedures. The outcomes from this study will provide the basis for specific testing recommendations consistent with the draft regulations and also provide information for acceptance or rejection of fly ash use.

Development of a framework for environmental assessment of fly ash applications is necessary for establishing criteria for fly ash usage in paving, infrastructure and agriculture applications. Currently, policy choice is under development and discussion in both the European Union and the United States. In both regions, a similar general approach is used, however, differences between the two regions are in establishing the

point of compliance, whether the thresholds are based on cumulative release or leaching concentration, and consideration of regional geology and hydrology. It is proposed that both methodologies will be reviewed and a methodology appropriate for Israeli conditions will be recommended.