Only limited data are available on the actual concentration of lead-acid batteries in MSW. A 1987 study at a materials recovery facility in Gallatin, Tennessee, removed about 70 batteries from 6,332 megagrams (Mg) (6,965 tons) of MSW over a 3-month period. This is equivalent to about one battery per 90 Mg (100 tons) of MSW. However, contacts with other material recovery facility operators indicate that the concentration of lead-acid batteries in MSW may range from one battery per 300 Mg of MSW up to one battery per 700 Mg MSW. Where lead-acid battery collection/separation programs have been implemented, battery contamination levels of less than one battery per 500 Mg of MSW are probably typical. One of the facilities contacted by the EPA reported finding no batteries in the MSW inspected at the facility over a 6-month period during which the facility processed 4,000 tons of MSW per month.

One lead-acid automotive battery (containing about 20 pounds of Pb) per 500 Mg (550 tons) of MSW is equivalent to a Pb concentration in MSW of about 20 parts per million (ppm). However, lead-acid batteries are not the sole source of Pb in MSW. Other sources are lead foils, light bulbs, circuit boards in electrical devices, automobile wheel weights, polyvinyl chloride plastics, yard waste, wood, food, textiles, paper, and inks for some newspapers, magazines, and packaging. One 1988 report estimated that the combustible fraction of MSW had a Pb concentration of 330 ppm based on a life-cycle analysis of lead-containing products.

The concentration of Pb in MSW can be estimated from the concentrations of Pb in MWC ash. There is a relatively constant relationship between the weight of MSW combusted and the weight of ash produced (bottom ash plus fly ash collected from the air pollution control devices (APCD's)). Furthermore, nearly all of the Pb (greater than 99 percent) entering the MWC in the MSW stream is retained in the bottom ash from the MWC and residue (ash) discharged from the APCD. The typical Pb concentration in combined MWC ash and APCD residue ash in about 2000 ppm, by weight, and combined ash represents about 30 percent, by weight, of the original MSW combusted. Based on these relationships, the estimated lead concentration in MSW is about 600 ppm. This estimate is considered to be a good estimate of the Pb concentration in MSW.

Based on a Pb concentration in MSW of 600 ppm, one battery per 100 tons of MSW would contribute about 100 ppm of Pb, or 16 percent of the total Pb in MSW. One battery per 500 tons of MSW would contribute about 20 ppm of Pb, or about 3 percent of total Pb input. At these contribution levels, additional efforts to remove lead-acid batteries from the MSW entering an MWC would have little impact on the amount of lead entering the MWC and little effect on controlled lead emissions.

IV. Supplemental Information on the Effects of Lead-Acid Battery Combustion on MWC Emissions

The remand requires the EPA to explain why it did not include a lead-acid battery prohibition in the February 11, 1991 standards and guidelines. The remand raises the question of whether lead-acid battery removal from MSW would reduce Pb emissions from MWC's. It is clear that Pb is contained in both the MSW stream being combusted and in MWC emissions discharged to the atmosphere. However, it is not clear whether uncontrolled and controlled Pb emissions are proportional only to the total amount of Pb input, or whether they may also be related to the form in which Pb or Pb compounds occur in the MSW. That is, is Pb more efficiently volatilized when it is in the metallic form, such as in lead-acid batteries, than when it is a trace component of paper, plastics, or other MSW material?

In order to determine the effect of lead-acid battery combustion on MWC emissions, a test program was sponsored by Environment Canada, the EPA, the International Lead Zinc Research Organization, and the Greater Vancouver Regional District in British Columbia, Canada. The test program studied the effect of lead-acid batteries on MWC stack emissions and on Pb levels in the fly ash and bottom ash by intentionally spiking MSW being combusted with lead-acid batteries.

Testing was performed on a 240 Mg/day (265 ton/day) mass burn/waterwall combustion unit at the Burnaby, British Columbia, MWC in June 1991. This MWC has a spray dryer/fabric filter-type acid gas/particulate matter APCD. The testing consisted of spiking MSW fed to the MWC unit with lead-acid batteries at the rate of four batteries per hour. This spiking increased the Pb input to the unit by about eight times (800 percent increase), from about 7 kg (15 lb) per hour (baseline) to about 56 kg (125 lb) per hour. The spiking was equivalent to 40 batteries per 90 Mg (100 tons) of MSW, or a Pb concentration in the MSW of about 4,000 ppm.

At the Burnaby MWC, about 1 hour is needed for MSW to travel from one end of the combustion grate to the other. At a spiking rate of four batteries per hour, there were four batteries, on average, on the grate at any given time during the spiking tests.

Testing at the Burnaby MWC consisted of 10 4-hour test runs over a 5-day period. Spiking with lead-acid batteries was performed during two of the runs. Other runs served as baseline control runs. During each run, the MSW fed to the unit was sampled, sorted into 78 categories, and analyzed for metals content. This test is the first to perform controlled spiking of lead-acid batteries to an MWC to study their effect on stack Pb emissions. It is also one of the most through analyses of the metals content of MSW.

The spiking of batteries to the Burnaby MWC did not measurably alter the Pb concentration in the stack gases either before or after the APCD. There were significant Pb increases in the ash residues from the boiler and from below the combustor grate. In the boiler, Pb increased in the section where the temperature is low enough to promote lead chloride (PbCl) condensation. The Pb increase in the grate siftings ash is caused by the Pb metal and Pb sulfate in the battery melting and dripping through the grate and forming beads of Pb metal in the grate siftings and bottom ash. The Pb in lead-acid batteries is not exposed to the appropriate conditions to be volatilized and carried into the flue gas to the APCD's or to the stack. The results of the Burnaby MWC testing program are summarized in table 1.

TABLE 1.—LEAD CONCENTRATION AT AIR POLLUTION CONTROL DEVICE INLET AND OUTLET DURING CONTROL AND BATTERY SPIKING RUNS

Test condition	APCD inlet (μg/dscm)[a]	APCD outlet (μg/dscm)[a b]	APCD efficiency (percent)
Baseline condition	8,764	51.8	99.4
(Range)	.....	(42.0–61.6)	.....