Influence of condensed silica fume (CSF) addition as cement replacement material on the properties of cement-based solidification products was investigated. Final setting, unconfined compressive strength, and leachability of the synthetic lead and chromium hydroxides were determined. CSF was used at 0, 5, 10, and 20 wt.% substitution for Portland cement. A water-to-solid ratio (w/s) of 0.45 was used for all mixes. Experimental results showed that the severe retardation effect on ordinary Portland cement (OPC) hydration caused by lead hydroxide has been minimized due to the pozzolanic effect and, as a result, the time to final setting has been significantly reduced. In addition, compressive strength of the solidified wastes was increased to the highest with 10% cement replacement but decreased to lower than the one without CSF at 20% replacement. Leaching of the amphoteric lead and chromium hydroxides is primarily determined by leachate pH and therefore lead was found in the leachates at higher concentration than chromium.