‘‘*Measurements of Lead, Bismuth and Selenium Discharge From Water Service Valves and Fittings Manufactured From Sebiloy (EnviroBrass II) Brass Alloy*’’

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I. BACKGROUND AND INTRODUCTION

In recent years it has become recognized that exposure to lead, especially in infants and young children, causes permanent and essentially irreversible neurological damage leading to IQ reductions, attention deficit disorders, and aggressive behavior (1, 2, 3). In light of these research findings, in 1991 the US EPA set a Maximum Contaminant Level Goal (MCLG) of zero for lead, and very recent published research has documented measurable childhood IQ deficits at blood lead levels as low as 2.5 Φg/dL, a level previously believed to be well below the threshold for observable neurologic damage (4, 5).

Currently, most brass plumbing and water service parts are still being made from leaded brass alloys containing between about 2 and 7 percent lead. It is now well documented that these leaded brass parts discharge substantial amounts of lead into residential drinking water, especially when new, but even after years of in-line service (6, 7, 8, 9). A large comprehensive study in 1996 by Lytle and Schock, with the US EPA, found that virtually all such leaded alloys leached and discharged substantial concentrations of lead for extended periods (6). A series of experiments conducted by the UNC-Asheville Environmental Quality Institute (EQI) on water meters and valves documented that new leaded brass parts typically leach about 100 Φg/L of lead initially, with the levels typically decreasing to less than one-half of initial values within weeks, followed by a long-term stabilization at moderate lead discharge levels (5-30 Φg/L), depending on supply water corrosivity after about five months of service (7, 8, 9).

Another recent study by the EQI found that leaded brass curb valves and water meters in the Los Angeles public water system were still discharging high amounts of lead after two or more years of service. These discharges were calculated to be sufficient to cause significant exposures, measurable increases in blood lead levels, and IQ deficits among Los Angeles children (10, 11). Based on these findings, the City of Los Angeles Department of Water and Power is now only purchasing no-lead parts for their water distribution and delivery system.

With the national discontinuation of leaded plumbing solder in new buildings (1988), the virtual elimination of leaded brass in kitchen faucet fixtures (1996-1999), and most recently, the phase-out of leaded brass water meters in California (2001), residential exposure to lead from drinking water is decreasing significantly. However, with the elimination of lead from solder and many brass plumbing parts, lead discharge from leaded brass water meters and associated service parts such as curb valves, curb valve tail pieces, elbows, and corporation stops are now the greatest source of drinking water lead exposure in newer buildings. As noted above (10, 11), these remaining leaded-brass service parts are a significant source of childhood lead exposure, which would appear to be quite unnecessary given the increasing availability of no-lead alternatives. There are presently two no-lead-added type brass alloys which are most commonly being used in plumbing parts. These are Federalloy I-836, which is a bismuth brass, and Sebiloy I (a.k.a EnviroBrass II), which in addition also contains about 0.7 percent Selenium. Both alloys contain lead only as an incidental impurity at a level of about 0.1 percent or less. The lead and bismuth discharge from water service parts made from Federalloy I-836 has previously been investigated and has been found to be extremely low (12).

The purpose of the research described herein was to test, quantify, and compare the lead discharge of 30 different representative no-lead brass water service products poured by Cambridge Brass using Sebiloy II brass alloy.

II. METHODOLOGY

The testing methodology for this research was designed to match as closely as possible the

testing methodologies employed previously by the EQI for determining actual lead discharge from plumbing parts (9, 12, 13).

The EnviroBrass II alloy products tested by this research are listed and described in Table I below.

TABLE I. Description of EnviroBrass II Plumbing Products Tested for Lead, Bismuth and Selenium Discharge Dynamics.

Product ID#	***Product Description***
202NL-F7F7H	2" Ball Valve Curb Stop
202NL-H3H3	3/4" Ball Valve Curb Stop
105NL-H3M3	3/4" Elbow Coupling

After thorough rinsing and pre-conditioning as specified by NSF-61 Section 9 (14), the individual components (141 total) were plumbed with PVC or polybutylene connectors or adapters to the EQI lead-free research pressurized manifold system. An extraction water was prepared that closely simulates average California public water supply characteristics in terms of lead corrosivity (15). This water had an average pH of 8.04 (+ or - 0.3), mean hardness of 100 mg/L (as $CaCO_3$), mean alkalinity of 82.4 mg/L (as $CaCO_3$)(+ or - 5 mg/L) and total chlorine of 1.0 mg/L. Using laboratory pumps and timers, this extraction water was fed to the test parts with five water changes per day. Samples from the EnviroBrass II products were taken on each weekday morning for three weeks after a 16-hour overnight internal dwell time. The conventional brass products were sampled on Days 3, 4, 5, 10, 11, 12, 17, 18, and 19. On Days 17, 18 and 19, shorter dwell time samples were taken after 10 minutes, 30 minutes, and 2 hours. This short dwell time data enabled a calculation of the approximate total daily lead discharge from the parts and as well as the approximate ingestion by residence occupants. The lead discharge concentration data were statistically analyzed to determine a lead discharge AQ@statistic as defined for certification purposes by NSF (13). Thus, the experimental procedures used were virtually identified to NSF-61 Section 9 with the exceptions of 1) the parts were plumbed rather than just >dumped and filled=, 2) water hardness, alkalinity and total chlorine levels used were more representative of typical public water supplies than the levels specified under NSF, and 3) short dwell time samples were taken in addition to 16-hr. overnight dwell samples.

All samples were analyzed for total lead by graphite furnace atomic absorption spectrophotometry (GFAAS) with a NELAP national drinking water compliance certification lower reporting limit of 2.0 Φg/L, but an actual research method detection limit of about 0.5 Φg/L. Instrument readings of less than 0.5 Φg/L were reported and were used for statistical analyses to avoid the problems associated with truncated data sets.

III. RESULTS AND DISCUSSION

As expected, the lead discharges from the EnviroBrass II water service parts were quite low. Lead discharge results are summarized in Table 2 with the complete data tabulated as Appendix A and, as expected, are very similar to those observed previously for Federalloy I-836 parts (12).

TABLE 2. Summary of 16-hour Dwell Lead Discharges (Φg/L)(250-mL samples).

Product ID#	***Mean Internal***	***Mean Lead***	***Mean Lead***	***Mean Lead***	***Overall***	***1-L Adjusted***	***>Q= Stat***

	Exposed Volume (mL)	***Days 3-5***	***Days 9-12***	***Days 16-19***	***Mean***	***Overall Mean***	
202NL-F7F7H	150	7.3	3.6	1.7	4.2	1.04	1.48
202NL-H3H3	31	9.8	5.7	3.2	6.3	1.57	2.08
105NL-H3M3	32	7.7	3.7	1.9	4.4	1.11	1.43

The Q-Statistics for these three part types was quite low and well within previous California Prop 65 settlement standards.

As shown in Appendix A, Bismuth and Selenium discharge from these parts were also very low. Bismuth discharge concentrations were virtually identical to those observed previously for similar model parts made from Federalloy I-836. Selenium discharge from the EnviroBrass parts was virtually negligible (barely detectable) even on Day 3 (i.e., Day 1 of actual testing), and for this reason, no more Selenium measurements were taken for Days 4-19. This was quite a surprising result given that the Sebiloy II alloy contains 0.7 percent Se.

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REFERENCES

1. Needleman, H.L. and C.A. Gatsonis. 1990. *Low-Level Lead Exposure and the IQ of Children: A Meta-Analysis of Modern Studies.* Journal of the American Medical Association, 263(5):673-678.

2. Schwartz, J. 1994. *Low-Level Lead Exposure and Children=s IQ: A Meta-Analysis and Search for a Threshold.* Environmental Research, 65:42-55.

3. Needleman, H.L. *et al.* 1990. *The Long-Term Effects of Exposure to Low Doses of Lead in Childhood: An 11-Year Follow-up Report*. New England Journal of Medicine, 322:83-88.

4. Schramm, M. and M. Watt-Morse *et al.* 2000. *Release of Stored Bone Lead During Pregnancy*. Journal of Epidemiology, November 2000.

5. Lanphear, B. 2001. *Cognitive Deficits Associated With Blood Lead Concentrations < 10 Φg/L in US Children and Adolescents*. Public Health Reports.

6. Lytle, D.A. and M.R. Schock. 1996. *Stagnation Time, Composition, pH and Orthophosphate Effects on Metal Leaching From Brass.* EPA/600/R-96≅103, September 1996.

7. Maas, R.P., S.C. Patch, D.M. Morgan and H. Kawaguchi. 1997. *Lead Leaching From Brass Water Meters Under Pressurized Flow Conditions*. Proceedings of the American Water Works Association 1997 Annual Conference, 589-602.

8. Maas, R.P., S.C. Patch, D.M. Morgan and S.C. Loucaides. 1999. *Lead Leaching From Los Angeles In-Service Brass Water Meters*. UNC Asheville Environmental Quality Institute Technical Report #99-068. 17p.

9. Maas, R.P. and S.C. Patch. 1999. *Lead Leaching From In-Service Residential Water Meters: A Laboratory Study.* Source (CA Section of AWWA), 100(3):27-28.

10. Maas, R.P. 2001. *Estimation of Human Lead Exposure From In-Spec (<6% Pb) and Out-of-Spec (> 6% Pb) Leaded Brass Curb Valves, Curb Valve Tail Pieces, Elbow Connector Nuts, Corporation Nuts and Corporation Threads,* April 30, 2001. 8p.

11. Maas, R.P. 2002. *Estimation of Human Lead Exposure from Leaded Brass Water Works Parts Installed in Residential Service.* UNC Asheville, EQI, April 2002. 9p.

12. Maas, R.P., S.C. Patch, J. Berkowitz and M. Lagasse. 2002. *Comparison of Lead Discharge From Conventional Leaded Brass Versus ANo-Lead@ Type Water Service Valves and Fittings.* UNC Asheville Environmental Quality Institute Technical Report #02-097. 22p.

13. Maas, R.P., A. Parker and S.C. Patch. 1998. *Lead Leaching From In-Service Leaded-Brass Water Meters*. NC Journal of the American Water Works Association, Vol. 1:270-279.

14. ANSI/NSF. 2001. *Section 9, Testing of Drinking Water Components*. Available from NSF, Ann Arbor, MI.

15. Maas, R.P. and M.S. LaGoy. 1999. *Survey of Average California Public Water Supply Corrosivity Characteristics.* UNC Asheville Environmental Quality Institute.