Draft Peer Review Charge Questions

July 28, 2014

Approach for Estimating Exposures and Incremental Health Effects from Lead due to Renovation, Repair, and Painting Activities in Public and Commercial Buildings

Issue 1. Monte Carlo and Sensitivity Analyses

The approach uses Monte Carlo modeling to explore variability within exterior and interior exposure scenarios. All combinations of scenario variables have been modeled and a distribution of results for each scenario was developed by iterating 10,000 times for exterior scenarios and 3,000 times for interior scenarios from the sampled variables.

Question 1a. Please comment on the use of the Monte Carlo analyses to explore the variability within each exposure scenario. Please comment on the strengths and weaknesses of the Monte Carlo analyses.

The Approach further explored variability through a sensitivity analysis for one interior scenario and one exterior scenario. The sensitivity analysis techniques are being used to examine the impact of sources of uncertainty on exposures. The sensitivity of the estimated exposures to assumptions about different scenario conditions can reflect the differential scales in which those conditions are measured. OPPT has also chosen to express sensitivity by an "elasticity" measure, which normalizes the inputs.

Question 1b. Please comment on the strengths and weaknesses of the sensitivity analysis. Please comment on OPPT's use of both elasticity and sensitivity scores to evaluate the impact of changes in assumptions on results.

Issue 2. Estimates of Lead Dust Loadings and Concentrations

The Approach estimates an "emission fraction" from exterior renovations which is then used to estimate an emission rate for the AERMOD model. This is described in Section 4.2 and Appendix H. The Approach estimates a "fraction emitted" from interior renovations, which is then used to estimate interior lead dust loadings. This is described in Section 5.2 and Appendix I. EPA's Dust Study was the primary data source that contained all the required contextualizing information to process the information for use in the Approach. EPA supplemented information from the EPA Dust Study in a targeted way to estimate loadings resulting from exterior and interior demolition as well as to better inform post-renovation cleaning practices. One of the approaches considered was supplementing dust loading data within indoor air data derived through industrial hygiene sampling. For exteriors, the dust study processing steps are described in Appendix H and important considerations include the distance of the sample from the renovation job, the size of the job, and mass of lead in the paint. For interiors, the dust study processing steps are described in Section 4.2, and important considerations include the size of the job, the size of the work area, and mass of lead in the paint. Estimating a "fraction-emitted"

allows loadings to be estimated and scaled for a wide variety of room sizes, job sizes, and lead content present in the universe of P&CBs. Loadings are estimated for the work-area, the workroom, and adjacent rooms. Loadings in each of these rooms were individually estimated for each type of activity and then composite loadings were estimated for each multiple activity scenario by summing the relevant activity-specific loadings for each type of room. Department of Energy reference buildings described in section 5.1 of the Approach were used to develop generic room sizes and building layouts. Use of the Dust Study data to estimate lead dust loadings for P&CBs does introduce uncertainty as described in Section 9.1.1.

Appendix K of the Approach document describes an empirical based method for converting lead loadings to lead concentrations. This method was recommended over a mechanistic mass-balance model approach when both approaches were presented to EPA's Science Advisory Board as part of a peer consultation in 2011. The difference between the empirical approach presented in 2011 and the empirical approach presented in this document is the addition of two data sources.

Question 2a. Please comment on the steps taken to process the EPA Dust Study data described in detail in sections 4.2 and 5.2 as well as appendices H and I, and on the Approach to supplement Dust Study Data with information from other sources including the conversion of indoor air concentrations to indoor dust loadings.

*Question 2b.*Please comment on the availability of any other empirical data that contains lead dust loadings or indoor air concentrations, and supporting information, in buildings during and after renovation activities that disturb lead based paint. Please comment on any suggestions to reduce uncertainty in estimating dust loadings present after a renovation, including at their upper ranges.

Question 2c. Please comment on the data sources and method used to convert lead loadings to lead dust concentrations.

Issue 3. Estimates of Transport of Exterior Lead Dust to Nearby Buildings

The Approach describes how exterior renovation activities generate aerosolized lead dust which can be transported to and penetrate the outer shell of nearby buildings. The Approach also describes how exterior renovation activities generate lead particulate debris (larger particles) which are not transported through the air, but can be tracked into buildings. Both of these contribute to indoor dust loadings. This is described in detail in Section 5 and Appendices G and J. EPA's AERMOD model was used to estimate transport through the air. A Dust Model developed for this analysis was used to estimate track-in and removal of lead dust over time. The Dust Model was also presented to EPA's Science Advisory Board in 2011 as part of a peer consultation.

Question 3. Please comment on the approach and models used to estimate outdoor air concentrations, outdoor soil and hard surface concentrations, and indoor dust loadings resulting from exterior renovations.

Issue 4. Estimates of Exposure to Children and Adults

EPA considered environmental concentrations resulting from renovations (as described in Issue 2 and 3) and combined this information with age-specific exposure factors and activity patterns to estimate exposures. Exposure factors were derived from EPA's Exposure Factors Handbook and Activity Patterns were derived from EPA's Consolidated Human Activity Database (CHAD). A sensitivity analysis was performed to determine how the location of an exposed individual (within one room or moving in multiple rooms) combined with exposure start-time influenced results and is described in Section 8. Activity patterns were varied by age and by building type and are summarized in Appendix L.

Question 4. Please comment on the overall approach for estimating exposures (both interior and exterior) through use of exposure factors organized by age, and by activity patterns, organized by age and building type.

Issue 5. Leggett Blood Lead Modeling

The Approach uses an updated Leggett blood lead model to estimate both childhood and adult changes in blood lead. The updates included scaling tissue lead concentrations for children and adolescents, evaluating and updating the bone lead transfer rates, and evaluating and calibrating the model using human data sets for both children and adults.

Question 5a. Please comment on the updates to the Leggett model and the choices made in evaluation of data sources and calibration of the model for children and adults

Question 5b. Please comment on the use of the updated Leggett model to estimate blood lead levels for both children and adults in the Approach.

The Approach estimates blood lead level metrics using background values and for the renovation only. Concurrent and lifetime blood lead metrics are estimated as outputs from the Leggett model. Concurrent blood lead metrics were estimated at nine different time-steps post renovation. Lifetime blood lead metrics were estimated based on the age of person at the start of renovation and the time it takes for their blood lead to return to background. The lifetime will vary across exposure scenarios. Incremental bone lead change was also estimated as another metric of lead body burden.

Question 5c. Please comment on the various outputs derived from the Leggett model (concurrent blood lead, lifetime blood lead, and bone lead) and their appropriateness for use in concentration-response functions for children and/or adults.

Issue 6. Estimates of IQ Change / Characterization of Changes in Children's IQ

In the Approach, EPA estimated IQ reduction based on both concurrent and lifetime average blood lead concentrations based on the Lanphear et al. 2005 and Crump et al. 2013 studies. For

concurrent blood lead, the Monte Carlo analysis estimated potential IQ loss based on a single "measurement" (simulated blood lead concentration) for a predetermined (simulated) time after renovation, and IQ loss will be estimated based on the regression coefficient from the Lanphear/Crump log linear model for concurrent blood lead. Lifetime average blood lead was estimated based on the time-weighted average blood lead concentrations from birth until blood lead returns to background as generated by the Leggett model, and the lifetime average regression coefficients will be used to estimate potential IQ loss.

Question 6. Please comment on the use of the log-linear IQ model (concurrent and lifetime) for children up to age 10.

Issue 7. Estimating Adult Health Effects

A weight of evidence approach was used to consider which health effects in adults might be appropriate for this analysis. Based on the findings presented in the EPA ISA for Lead and the NTP Monograph on the Health Effects of Low-Level Lead, concentration-response functions were derived from studies representing renal, reproductive, developmental, and cardiovascular effects. However, there are several issues related to estimating adult health effects that complicate the analysis applied in the Approach.

1. There is a lack of understanding about the contribution of past versus recent lead exposures in adults to health effects, especially chronic health effects that may require years of insult to produce an effect (e.g., cardiovascular disease).
2. Adults have stores of lead in bone, which reflect cumulative (lifetime) lead exposures. However, the renovation exposure scenarios being modeled for the Approach are relatively short exposures, better reflected in blood lead measurements.
3. Most of the available studies report on cohorts with higher blood lead levels than those currently reported for the majority of the US population (approximately 1 µg/dL). Often the data derived from the concentration-response functions at blood lead levels below 1 are highly uncertain, given the lack of data at these levels.
4. In the Approach document, renal, reproductive, developmental, and cardiovascular effects are examined separately, although there may be feedback effects among them (e.g. cardiovascular disease is frequently associated with chronic kidney disease, and CKD appears to be a risk factor for CVD).

Because these studies report effects most often observed in adults with likely higher past Pb exposures, uncertainty exists as to the Pb exposure level, timing, frequency, and duration contributing to the associations observed with blood or bone Pb levels.

Question 7a. Please comment on the appropriateness of deriving concentration-response functions for Cardiovascular Disease Mortality (CVDM), reduced kidney function, and low birthweight, and their use for estimating incremental adult health effects due to renovation activities for P&CBs.

Question 7b. Blood lead levels continue to decrease in the US. Please comment on the appropriateness of using concentration-response functions from studies in which the overall

blood-lead levels are relatively higher than contemporary levels in the US adult population, particularly in light of inflection points in the concentration-response functions for certain health effects (e.g. CVDM) below or above which the data do not demonstrate a positive relationship between lead exposure and adverse health impacts.

Question 7c. Concentration-response functions based on blood lead are more prevalent in the health impacts literature, while studies using bone lead are not available for all health endpoints. Please comment on the use of blood lead and bone lead as biometrics for projecting incremental health effects due to renovation activities for P&CBs.

Question 7d. In this Approach, EPA estimated adult health impacts based on concurrent and lifetime average blood lead concentrations. Please comment on the appropriate time horizon over which to estimate adult health outcomes (Section 7.3.1) and whether this differs across health endpoints.

Issue 8. Overall Draft Approach

EPA has developed an Approach document for estimating incremental health effects resulting from exposure to lead from renovation, repair, and painting activities in public and commercial buildings (P&CB). The approach is intended to provide an overview of the data sources and models used to estimate environmental media concentrations and exposures, blood lead levels, and incremental health effects.

Question 8. Please comment on the overall Approach and its utility for estimating incremental health effects due to renovation activities on the exteriors and interiors of P&CBs. Please comment on the clarity and transparency of the document.