Appendix A4

Parameterization of Risk Assessment Model

PARAMETERIZATION OF RISK ASSESSMENT MODEL

The following bullets detail how each of the variables in the risk assessment model were selected. Values reflect either site specific input from meeting with Laotian team members or Health Canada default values (Health Canada 2004).

- **C_S** (Soil Concentration, used by the following pathways: accidental soil ingestion, inhalation of contaminated particles and dermal contact with contaminated soil; units = mg/kg dry). It was anticipated that employees may be exposed to workshop dust and outdoor SPL soils during a shift, and contaminated oils while working in the workshop and cooking food at home. Employee families may be exposed to contaminated oils and ash material which is generally deposited in yards. School children and local residents would only be exposed to near-field off-site soils. The maximum soil/dust concentrations of dioxins/furans + DL-PCB TEQs measured in soil were used for modeling most of the scenarios. However, for scenarios involving dermal contact with transformer oils, there were no available measurements of contaminant concentrations. For the dermal contact scenarios, a range of possible exposure concentrations was used in the model. The highest indoor soil (dust) concentration was used as a daily low range concentration (0.000318 mg/kg dry) for dermal contact with soils/dust. To address periodic contact with more oily material (e.g., spilled oil or unprotected handling of PCB-related oils), an upper range of exposure concentration was assumed to be 100x higher (i.e., 0.0318 mg/kg dry). This value, based on professional judgement, reflects that transformer oils worldwide were typically manufactured using a mixture consisting 60% (or greater) Aroclor (Paleologou 1993), and additionally that a commonly used Aroclor mixture (1260) has a TEQ concentration on the order of 3.5 mg/kg (Rushneck 2004). This infers that TEQ concentrations in transformer oils could conceivably be 1000x to 10,000x higher than what was measured in soils collected from the workshop floor. Note however, that the contact rate with oily substances is significantly less than daily contact with soils (see notes on exposure frequency (EF) for dermal exposure).

- **C_{Food}** (Concentration measured in food, units = mg/kg wet). The concentration of dioxins/furans + DL-PCB TEQs in a fish caught downstream of the site was used in the model.

- **P_{Air}** (Concentration of particulates suspended in the air, units = µg/m^3). The Health Canada default value (0.76 µg/m^3, as per USEPA 1992), was considered too low for Lao PDR. Instead, a value of 300 µg/m^3 for workshop air and 100 µg/m^3 for all other scenarios were adopted during meetings with Laotian team members.

- **IR_S** (mass of soil per day accidentally ingested, units = mg/day). The rate value used was taken directly from the Health Canada default table (0.00002 kg/day). The same rate was used for both children and adults. This means that on a per body weight basis, children accidentally consume about double the amount of soil than an adult (children are 32.9 kg, compared to an adult weight of 60 kg; see Bw below).

- **IR_{Food}** (mass of contaminated food per day ingested, units = kg/day). The default Canadian values were adopted for the model (0.11 kg/day for adults and 0.09 kg/day for children).

- **IR_A** (volume of air inhaled each hour, units = m^3/hr). This variable is used for the inhalation pathway only. The rate value for adults and children were taken directly from the Health Canada default values. Note that Health Canada default values are presented in units of m^3/day and therefore were divided by 24 hrs/day to get units of m^3/hr (i.e., 0.66 m^3/hr for adults and 0.60 m^3/day for children).

- **SA_H** (surface area of skin exposed to contaminated soils, units = cm^2). This variable was derived using the Health Canada default values. While working in the workshop, it was assumed that both hands and arms could be exposed and therefore a value of 3390 cm^2 (2500 + 890) was adopted. For the other scenarios, it was assumed that only part of the hand may be exposed and therefore a value of 890 cm^2 was adopted (590 cm^2 for children).

- **SL_H** (Soil loading to exposed skin, indicates the usual surface area coverage per volume of contaminated soil, units = g/cm^2 - event). The Health Canada default value (0.0001 g/cm^2 for hands) was adopted for soil exposures. For transformer oil exposures, a larger value would be appropriate as there would be a greater contact of contaminant with skin. For transformer oil exposures, we assumed a value of 0.0009, which is the approximated 95 percentile value for SL_H skin exposure of a utility worker (USEPA 2004).

- **AF_{GIT}** (absorption factor across the gastro intestinal tract, units = unitless). This variable was used both for accidental soil ingestion and food ingestion pathways. There are no readily available AF_{GIT} values for total dioxins/furans + DL-PCB TEQs. In these cases, Health Canada guidance recommends adopting a conservative estimate of "1". This indicates that 100% of chemical is absorbed across the gastrointestinal tract into the body.

- **AF_{Inh}** (Absorption Factor for the lungs, units = unitless). There are no readily available AF_{GIT} values for total dioxins/furans + DL-PCB TEQs. In these cases, Health Canada guidance recommends adopting a conservative estimate of "1". This indicates that 100% of chemical is absorbed across the lungs into the body.

- **AF_{Skin}** (Absorption Factor for the skin, units = unitless). For dioxins/furans + DL-PCB, an AF_{Skin} of 0.14 was adopted, this is the absorption factor for PCB Aroclor mixtures <u>in soil</u> provided by the USEPA (USEPA 2004). For dermal contact with contaminated transformer oils a AF_{Skin} of 0.5 to 0.8 was adopted as it is known that fat soluble contaminants dissolved in oils tend pass through skin more readily (i.e., oils are a dermal absorption vehicle). No known AF_{Skin} is available for this scenario. Although Health Canada guidance suggest a value of 1 is appropriate as a conservative default value for absorption rates, this is intended more for inhalation and ingestion; in the case of dermal contact, it is unlikely that absorption would be 100%.

- **EF** (number of dermal exposures per day, units = events/day). It was assumed that there would typically only be a single exposure event per day in all soil exposure scenarios. For potential dermal exposure to transformer oils, it was assumed that only 10 percent of transformer oils would have elevated concentrations of PCBs. Therefore, for dermal exposure to transformer oils an EF of 0.1 was used.

- **D_{hours}** (number of hours a day that an individual is potentially exposed, units = hrs/day). D_{hours} is used by the accidental ingestion and inhalation of contaminated particle pathways, but the value is slightly different for each exposure pathway. For accidental soil ingestion, it is assumed that individuals may only be exposed while they are near contaminated soils and also awake (i.e., 16 hours a day). The model assumed employees would spend eight hours inside the workshop and one hour outside the workshop at SPL. The same employee would spend an average of 9.6 hours per day at home, which is the daily average including time at home on weekends. Employee family members and local residents were assumed to have 16 hours of possible exposure per day. For inhalation of contaminated particles it was assumed that individual may be exposed at any time that they are near to contaminated soils, therefore the model assumed eight hours for an employee working in the workshop, one hour while working outside but still at SPL and 17.6 hours at home (daily average including weekends). All other scenarios, with exception of students, were assumed to have 24 hours of potential exposure per day. Local students were assumed to have nine hours of potential exposure per day.

- **D_{days}** (number of days per week, or days per year, that an individual is potentially exposed, units = days/week or days/year). D_{days} is used by all the exposure pathways, but the value is slightly different for each. For accidental soil ingestion, inhalation of contaminated particles and dermal contact, it was assumed that workshop employees and students would be potentially exposed five days a week, while all people in all other scenarios would be exposed seven days a week. The numbers were based on interviews with workshop employees, and were selected during meetings with Laotian team members. The food ingestion pathway uses days per year, which indicates the number of days each year that contaminated food items may be ingested. In this risk assessment it was assumed that only fish or other meat sources collected from the site were potentially contaminated and these would be consumed twice a month by employees and local residents.

- **D_{weeks}** (number of weeks per year that an individual is potentially exposed, units = weeks/year). D_{weeks} is used by the accidental soil ingestion, inhalation of contaminated particles and dermal contact pathways. It was assumed that the person (either an employee, employee family member, local resident or student) would be potentially exposed most weeks of the year, but would not be at the site during short periods of holiday or vacation. The numbers were based on interviews with employees, and were selected during meetings with Laotian team members. For the inhalation of contaminated particulates pathway, $D_{weeks,}$ should be multiplied by the proportion of weeks per year without rainfall. As it

is likely that air-borne particulates will only be available for inhalation when soils are dry. In this risk assessment, application of the proportion of dry weeks was not necessary, as the inhalation pathway was not a significant contributor to total daily dose.

- **D_{years}** (number of years that an individual is potentially exposed, units = years). D_{years} is used by all exposure pathways, but only in the non-threshold model (i.e., the carcinogen model). SPL employees were assumed to be working at the site for approximately 13 years, while local residents were assumed to be living in the community for 13 years. The numbers were based on interviews with employees, and were selected during meetings with Laotian team members.

- **BW** (Body weight, units = kg). Adults were assumed to weight 60 kg. The adult BW was developed during discussions with Laotian team members. The child body weight was estimated to be 32.9 kg.

- **LE** (Life expectancy, the number of year that the person is likely to live. Not used for non-carcinogens, units = years). It was assumed that the average life expectancy was 60 years. The live expectancy value was developed during discussions with Laotian team members.

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