TSERAWG Technical Guidance

This paper has been technically reviewed and endorsed by the Tri-Service Environmental Risk Assessment Working Group for use by Army, Navy, and Air Force Personnel

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Tri-Service Environmental Risk Assessment Workgroup Questions/Answers on Dioxin

What is dioxin?

Dioxin refers to a single chemical, 2,3,7,8-tetrachlorodibenzo para dioxin (TCDD) and by convention, also is used as a common reference for a group of similar chemicals called congeners. Dioxin, dioxins, and/or the dioxin-like compounds (DLCs), are the 29 halogenated aromatic hydrocarbon congeners that induce common toxic responses through similar biological modes of action (NAS 2006). DLCs are halogenated aromatic hydrocarbons that are structurally and toxicologically related to TCDD (EPA 2010a). For the purposes of this document, dioxin and DLCs will be referred to as "dioxins" except when specifically discussing TCDD. These include seven of the polychlorinated dibenzo dioxins (PCDDs), ten of the polychlorinated dibenzo furans (PCDFs), and twelve of the polychlorinated biphenyls (PCBs) (EPA 2010a). TCDD is used as the reference, or index congener to assess the toxicity of dioxin and DLCs as toxicity equivalents (TEQ)[1] to TCDD. Dioxins are widely distributed in the environment in low concentrations and are commonly detected in air, soil, sediment, and food. Human exposure to these compounds occurs primarily through the ingestion of contaminated foods (EPA 2012a). Dioxins have a strong tendency to bioaccumulate and tend to persist in the body with a half-life in adults of around six years (NLM 2004).

Why is dioxin a concern now?

Toxicity values for TCDD are in flux due to publication of EPA's analysis of TCDD toxicity under the Integrated Risk Information System (IRIS) program, including for the

[1] TEQ, or dioxin toxicity equivalence, is a method for estimating the toxicity of a mixture of dioxins, which are weighted by their relative potency and summed to the equivalent dose of TCDD (EPA 2010).

first time for TCDD, publication of an oral non-carcinogenic toxicity value[2], called a reference dose (RfD); publication of a cancer oral slope factor by the EPA is pending (EPA 2012a). Changes in TCDD toxicity values influence levels of dioxin in soils or sediment that are protective of human health; values considered protective by EPA are now lower and may change again when the cancer toxicity value is published.

Will screening levels and cleanup values change?

The previous EPA preliminary remediation goal (PRG) for dioxin in soil (EPA 1998) was 1000 parts per trillion (ppt) for residential reuse, and 5000 to 20000 ppt for industrial and commercial scenarios. The new PRG is 50 ppt for sites whose likely and future use is residential and 664 ppt for industrial/commercial sites. These values were published by EPA on their dioxin website in an information sheet titled *EPA Non-Cancer Toxicity Value for Dioxin and CERCLA/RCRA Cleanups*[3]*, and* are similar to those found in the EPA Regional Screening Level tables.[4] These PRGs may be used for site screening, but during the RI/FS, site-specific factors and results of the baseline risk assessment should be used to modify PRGs used as a starting point to develop remediation goals. Additionally, the uncertainty in the TEQ may be considered, especially if the site has little or no TCDD. Numerous States have guidance values for dioxin (EPA 2009) that RPMs may consider as appropriate for their site. EPA does not publish human health screening levels for sediment; these should developed by a risk assessor on a site-specific basis.

What type of DoD sites may be impacted?

DoD operations that may be associated with releases of dioxin include past use or testing of tactical defoliant herbicides such as Agent Orange, PCB transformer sites, and former medical incinerators due to relatively large amount of polyvinyl chloride burned in such incinerators. The largest current contributors of dioxin to the environment are combustion sources, including forest and grass fires. However, anthropogenic combustion sources and other current releases are controlled by various EPA regulations that address air emissions, wastewater discharge, and landfill disposal of dioxin (2012b) and will generally not be a concern for legacy site cleanup. Project managers at facilities holding such permits may be requested by regulatory agencies to modify their limits or monitoring requirements during the renewal process as a result of changes in dioxin toxicity values. When assessing legacy sites, knowledge of historic practices and whether routinely burned combustible sources included chlorinated substances should be considered to help determine whether areas used for open burning or fire training purposes may be an environmental source of dioxin.

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[2] Oral reference dose: 7×10^{-10} mg/kg-day.

[3] http://www.epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html

[4] EPA Regional Screening Level Table, http://www.epa.gov/region9/superfund/prg/. For carcinogenic effects the tables use toxicity values published by CalEPA and show screening levels of 4.5 ng/mg for residential reuse and 180 ng/kg for industrial/commercial reuse.

Site Characterization

What are its fate and transport characteristics?

Fate and transport of dioxins depend on the mechanism of release and how long the dioxins have been in contact with soil or sediment. Once deposited, dioxins stay tightly bound; binding is relative to total organic carbon (TOC) content of the matrix. Only if co-located with acids or strong organic solvents could dioxins be mobilized once bound to the soil or sediment matrix. Environmental investigations should focus on the potential for direct-contact pathways for human and ecological receptors, as dioxins are generally not sufficiently soluble to pose a leaching threat to underlying groundwater.

Under which circumstances should I consider sampling and analysis for dioxin at my site?

Sampling and analysis for dioxins should be considered when the conceptual site model (CSM) and historical information indicates a release from DoD operations may have occurred. See response above regarding types of DoD sites that may be impacted.

How can we distinguish site-releases from background?

Dioxins are ubiquitous in the environment at low levels and will be present in many areas even when no historical release has occurred. As a first step or as a practical rule of thumb in the absence of establishing site-specific background, TCDD and dioxin levels as TEQ may be compared to TEQ background ranges suggested by EPA (EPA 2000). Background levels of dioxin in soil range from 1 – 11 TEQ in rural soils and may be higher in urban soils (Lorber et al. 2009). For some large and complex sites, a statistical background comparison to a reference area may be required, but also may be determined using the forensic fingerprint approach, as often done for PAHs.[5]

Which analytic methods can be used to analyze to new PRGs?

EPA Method 1613 and EPA Method 8290 are more sensitive than the lower resolution EPA Methods 613 and 8280; they are able to provide results in the ppt to parts per quadrillion (ppq) range. EPA Method 8290 would be useful for analysis of groundwater or soil/sediment samples and Method 1613 useful for analysis of wastewater samples collected to satisfy Clean Water Act requirements. The project risk assessor should be consulted before selecting an analytic method to insure risk-based requirements will be met.

[5] For example, congener enrichment of Octachlorodibenzofuran (OCDF) in emissions from medical waste incineration has been found to be a potential indicator of unique source materials, whereas, because Octachlorodibenzodioxin (OCDD) dominates in many anthropogenic "background" profiles such as from urban sources of combustion deposits, particularly near urban roadways, its ubiquitous presence makes it much less useful as an indicator congener (Cleverly et al. 1997). Herbicide-related profiles may contain more 1,2,3,4,6,7,8-HpCDF and prevalence of 1,2,3,7,8-PeCDD in 2,4-D, which Cleverly et al. (1997) found to be absent from other combustion or non-combustion sources.

Is incremental sampling method recommended by the Tri-Services for dioxin sampling and analysis?

Incremental sampling methodologies may be useful for dioxin soil sampling, see the ITRC's *Incremental Sampling Methodology* (ITRC 2012) for further information. Careful consideration should be given to the (CSM) and the types of decisions being supported by data collected from the site prior to selecting any sampling and analysis method.

What are the risk assessment issues?

Does the TEQ method change for non-cancer risks?

Most previous site-specific dioxin risk assessments focused upon cancer risks only. The publication of a non-cancer reference dose now allows for these health risks to be explicitly calculated. The standard practice of using TCDD as the reference congener to assess the cancer and non-cancer toxicity of dioxins as toxicity equivalents has not changed. The TEQ method has been in use for some time and the new toxicity values do not change its implementation in risk assessments.

What about assessing ecological risk?

Publication of dioxin values in the IRIS database do not impact ecological risk assessment, as human toxicity values are not used to assess ecological risk.

How are dioxin-like PCBs addressed in the risk assessment?

If the mixture contains dioxin-like PCBs, then the risk of these compounds should be evaluated either as a dioxin TEQ or as PCBs, but not both for the same non-cancer Hazard Quotient or cumulative cancer risk. This avoids double-counting exposure risks.

Are bioavailability studies useful for dioxin?

Site-specific oral bioavailability estimates may be appropriate for dioxin-containing soil or sediments where there is concern for human ingestion, to account for the difference between the bio-accessible fractions from the soil matrix as opposed to the measured total soil or sediment TEQ (EPA 2010b). Results reported in the literature for relative bioavailability (RBA) of dioxins from soil range from 10% to 40% (EPA 2010b) (with some individual samples as low as 5% for specific TEQ profiles). Thus, adjustments to risk-based soil/sediment cleanup goals might be possible; however, additional costs of a RBA assay can be considerable and prohibitive. As a practical approach, risk assessors could employ a 10% to 40% adjustment factor of the cleanup goal to determine whether site-specific evaluations of bioavailability might sufficiently impact the decision to warrant the additional expenditure of funds. In general, both higher organic content and degree of aging tend to decrease the bioavailability of dioxins. Where decisions are made

with a goal of achieving background, or if site soil TEQs are already fairly close to the background range, site-specific RBA testing becomes less cost effective than a soil removal action.

What are the major risk management decisions potentially affected?

Project managers may need to decide whether to sample and analyze for dioxin at sites where it has not been performed as part of past investigations; or may need to decide whether to reassess where dioxin has been or continues being managed with remedial action. Determinations of whether to characterize possible dioxin contamination at sites should be made on a site-specific basis, considering the conceptual site model (CSM) and whether DoD operations might have led to dioxin contamination above background levels.

If I cleaned up dioxin in the past do I need to evaluate the protectiveness of that cleanup? Do I do this now or during a periodic- or 5-year review?

Sites with remedies in place where dioxins are contaminants of concern may in some cases have to be re-evaluated. Assessment should take place as part of the regular 5-year or periodic review process.

If I have a release at my site that requires cleanup to values using current IRIS dioxin toxicity values, what do I do in the future, after the cancer toxicity values are published?

If the site proceeds to having a remedy in place in a time frame that doesn't allow for evaluating human health risk using the new cancer toxicity value, then it would be a factor to consider during the first 5-year or periodic review at the site.

How do I manage sites that were cleaned up to 1000 ppt using the 1998 EPA guidance on dioxin?

As described above, managers should determine whether to reassess sites during the regular 5- year or periodic review process.

Where can I get more information?

Navy RPMs: Consult Navy Risk Assessment Workgroup Members of Naval Facilities Engineering Command HQ and Navy and Marine Corps Public Health Center
Army RPMs: Consult the Army Public Health Command Public Health Institute or the Army Corps of Engineers Environmental and Munitions Center of Expertise
Air Force RPMs: Consult the Air Force Center for Engineering and the Environment Technical Division

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Point of Contact

US Army Corps of Engineers, Directorate of Environmental and Munitions Center of Expertise (EM-CX)
Omaha, NE 68144
(402) 697-2585