HWC Risk Assessments: Ruled by Uncertainty

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EPA's Requirements/Guidance

- Many HWC facilities have been required to perform extensive multi-pathway risk assessments to estimate the potential health effects caused by the public's indirect exposure to compounds emitted by the facility.
- The U.S. EPA's Human Health Risk Assessment Protocol (HHRAP) provides official guidance on how to perform such assessments.

Guidance Basics

- The HHRAP recommends evaluating *reasonabl*e potential risks to receptors and he use of existing and site-specific information
- Where there is limited site-specific information is supplemented by generally conservative default data
- There are 3 General Receptor Scenarios
  – Residents
  – Subsistence farmers
  – Subsistence fishers

Risk Assessment Scope *vs.* Outcome

- These risk assessments can include over 100 compounds each requiring about 30 parameters to predict their atmospheric, terrestrial, aquatic, and biological transport and fate.
- Despite the expansive nature of the overall modeling, the final risk and hazard estimates are usually dominated by the impact of a few pathways and compounds.

Modeling Parameters that can Dominate Overall Risk Assessment Results

- Emissions
  - MACT *vs.* actual
  - Treatment of emissions below detection limits
- Site-Specific parameters
  - Deposition and Transport
- General parameters
  - Food-chain modeling

Example 1: Mercury in fish

- Hazard indices for subsistence fishers were almost entirely due to incremental mercury concentrations in fish which were strongly dependent on:
  - estimated emission rates of $HgCl_2$ vapor that was not detected in the stack gas,
  - an uncertain dry deposition velocity for $HgCl_2$,
  - the rate of soil erosion within the nearby watershed, and
  - the assumed bioaccumulation factors in the local waterbody

Estimated incremental mercury levels in local fish based on various modeling assumptions.

Emission rate	Emissions' Speciation	Bioaccumulation Factor	Fish Hg Concentration (mg/kg)
MACT	HHRAP	HHRAP	5.9
		Measured	2.4
	Measured	HHRAP	0.14
		Measured	0.056
Measured	HHRAP	HHRAP	0.15
		Measured	0.058
	Measured	HHRAP	0.0034
		Measured	0.0014

Example 2: Dioxins in Chickens and Eggs

- Cancer risks for subsistence farmers were dominated by dioxin exposure estimates through consumption of local chickens and eggs that were strongly dependent on:
  - the assumed soil ingestion rate for chickens
  - the biotransfer and bioaccumulation of dioxins in the chicken and eggs

Example 3: Hexavalent Chromium in farm products

- Estimated cancer risks from exposure to hexavalent chromium in animal products was also a major portion of the overall risk for farmers.
- Hexavalent chromium was not detected in any of the stack emissions testing.
- It was not necessary to try to derive an emission rate from the total chromium measurements, but this could be attempted.

Example 4: food chain modeling of organic compounds

- Volatile compounds such as benzene that are not known to bioaccumulate, are modeled as if they do.
- PAHs that are metabolized by higher trophic level organisms are assumed to be conserved.
- In some cases, the use of HHRAP guidance demonstrably violates mass conservation.

Solutions

- At times it may be possible to perform sampling specifically directed at better defining the critical parameters.
- Historical local or regional measurements may exist for site-specific modeling parameters.
- Measurements may also be used to benchmark the modeling results.
- Limited scale monitoring programs may be more efficient than extensive modeling studies.
- It may be possible to perform default "screening-level" analyses followed by detailed but limited site-specific modeling.

Conclusions

- Although the HHRAP provides very specific guidance it is often the handling of a few modeling parameters with high levels of uncertainty that determine the overall outcome of a multi-pathway risk assessment.
- While this is perhaps understandable, relatively modest efforts could significantly reduce modeling uncertainties and in the end be more efficient than the current practice of "uncertainty interpretation"