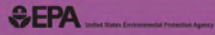


US EPA ARCHIVE DOCUMENT




MACT EEE Training Workshop

Dallas, Texas

November 3-7, 2008

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C.4 Site-Specific Risk Assessment

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National Risk Assessment

- Performed to determine if the MACT standards satisfy the RCRA mandate to protect human health and the environment.
 - Multi-media, multi-pathway analysis addressing both human health and ecological risk.
 - Predicated on the assumption that sources whose emissions were above the MACT standards would reduce their emissions to MACT levels, and that sources whose emissions were below the standards would maintain emissions at the existing levels.
- Determined that sources complying with the MACT standards are *generally* not anticipated to pose an unacceptable risk to human health and the environment. 

Since the MACT standards are technology-based, a national risk assessment to determine if they satisfied the RCRA mandate to protect human health and the environment was performed. This national assessment was a multimedia, multipathway analysis addressing both human health and ecological risk. The assessment was predicated on the assumption that sources whose emissions are currently above the MACT standards will reduce their emissions to MACT levels and that sources whose emissions currently are below the standards will maintain their emissions at current levels. Based on this national assessment, it was determined that sources complying with the MACT standards generally are not anticipated to pose an unacceptable risk to human health and the environment under RCRA. The conduct of the national risk assessment supported the conclusion that the technology-based MACT standards met the protectiveness requirement of RCRA sections 3004(a) and (q).


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SSRAs Continue to be Recommended

- Despite completion of National Risk Assessment
 - Uncertainties remain:
 - Non-dioxin PICs (which were not evaluated in the national risk assessment).
 - Mercury (where bioaccumulation is very dependent on local conditions).
 - Other site-specific factors that could vary from those evaluated in the national assessment.
- Given these uncertainties, site-specific risk assessments may be warranted in some cases.
 - Evaluate on site-by-site basis.




Although comprehensive, the national risk assessment did contain several uncertainties and limitations. As a result of those uncertainties, it could not be concluded that the MACT standards would be protective of human health and the environment in all cases, i.e., that it would never be necessary to include additional permit conditions in a specific facility's permit pursuant to the omnibus provision of §3005(c)(3).

For example, the national risk assessment did not include an evaluation of the potential risk posed by nondioxin products of incomplete combustion. In addition, the uncertainties associated with the mercury portion of the assessment were significant and limited the use of the analysis for drawing quantitative conclusions regarding the risk associated with the mercury MACT standard. Finally, the national risk assessment utilized generalized assumptions which may not be reflective of unique, site-specific considerations.

Thus, in some cases, a SSRA may be necessary to confirm whether operation of a particular hazardous waste combustor in accordance with the MACT standards will be protective of human health and the environment under RCRA.

The determination of whether a SSRA is necessary is intended to be made on a site-by-site basis.


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Determining Need for SSRA


- MACT rule provides qualitative factors for use in determining need for a site-specific risk assessment.
 - SSRA not a *de facto* regulatory requirement.



EPA developed a list of qualitative guiding factors for permit authorities to consult when considering the need for a SSRA.

Also, comprehensive (direct and indirect) SSRAs are not the only way to address the omnibus requirement. For certain low-capacity facilities, Region 3 has accepted inhalation-only risk estimates (with a carcinogenic risk target of 10^{-7} , and a noncancer hazard quotient of 0.01). In another case, only D/F and Hg risk assessment was required.


Therefore, SSRA is not a defacto regulatory requirement, but rather a true case-by-case consideration of the omnibus obligation.

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Qualitative Factors for Determining Need for SSRA

- Site-specific factors such as receptors, unique dispersion patterns, etc.
- Likely PICs and potential risk
- On- and Off-site sources that could influence risk
- Ecological considerations
- Adequacy of previously conducted risk assessment given changes in conditions



This slide shows some of the qualitative guiding factors for factors for permit authorities to use in determining whether the MACT will be sufficiently protective at an individual site, and consequently, whether an SSRA is warranted.

It is important to keep the decision to require an SSRA flexible because factors vary from facility to facility. However, as you can see, the factors are quite vague. Therefore, it is unlikely that the guiding factors in the MACT will rule out the need to conduct a SSRAs at many sites.


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Site-Specific Risk Assessment

- Intended to provide information to determine what, if any, additional conditions in the RCRA permit may be necessary to ensure that operation of combustion unit is protective of human health and the environment.
- Additional conditions have included:
 - Dioxin/Furan emission limits;
 - Operating conditions;
 - Waste feed rate limits.



SSRAs are intended to provide the necessary information to determine what, if any, additional conditions may be necessary to ensure that operation of a combustion unit is protective of health and the environment.


Examples of additional permit conditions that have resulted from SSRAs have included D/F emission limits, limits on operating conditions, and waste feed rate limits.

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Current Status of SSRAs

- Site-specific risk assessments have been performed for hazardous waste combustors since mid-1993, as a result of EPA's Hazardous Waste Minimization and Combustion Strategy.
- Most combustors permitted over the last 15 years have already conducted a SSRA.
- Those that have not are being asked by EPA to conduct a SSRA as part of the MACT performance testing, if appropriate.



SSRA's have been conducted for HWCs since the mid 90's. Most HWCs that have been permitted over last 15 years have already conducted a SSRA. Those that have not are asked to conduct a SSRA as part of the MACT performance testing, if appropriate.

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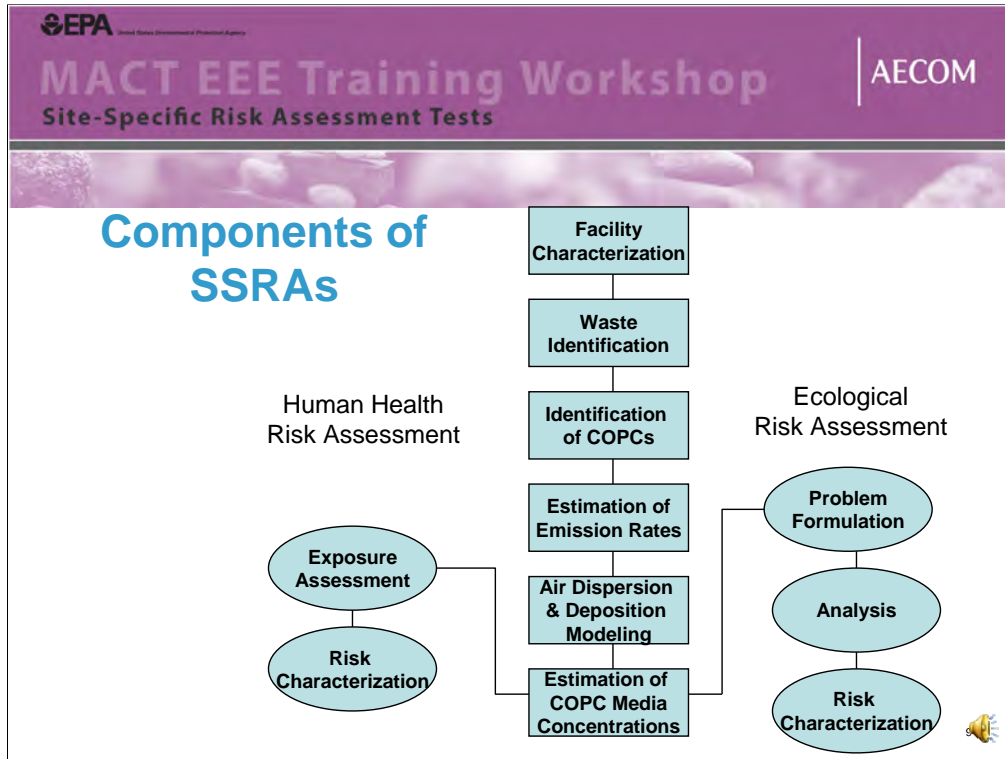
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SSRA Guidance

- Human Health SSRAs conducted in general accordance with U.S. EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (HHRAP; USEPA, 2005).
- Ecological SSRAs conducted in accordance with U.S. EPA's *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (SLERAP; USEPA, 1999). 💡

EPA guidance for the conduct of SSRAs include the *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (HHRAP) and *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (SLERAP). However, the 2005 update of the HHRAP states that the SLERAP is currently undergoing substantial revision and that until revisions are complete, using the SLERAP is not recommended.




This slide shows the various components of SSRAs. The boxes down the middle represent those tasks that are common to both human health and ecological risk assessment. The right side lists those tasks that are specific to ecological risk assessment, while those on the left are those specific to the human health risk assessment.

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Facility Characterization

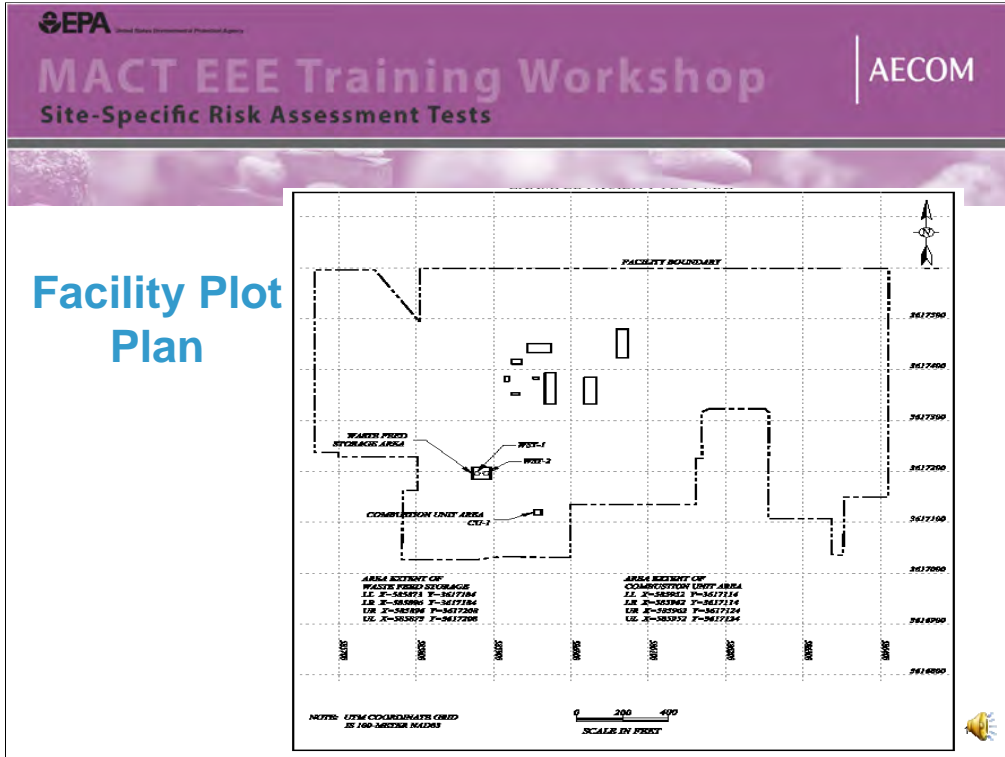
- Physical setting
 - On and off site
- Principal business and primary production processes
 - Max and normal production rates
 - If multiple units, are they used simultaneously
- Types and location of waste storage and treatment facilities
 - Sources of stack and fugitive emissions
- Basic facility data
 - Plot plans
 - Process flow diagrams showing both mass and energy inputs and outputs



The first step in the SSRA process is facility characterization.

There is basic facility information that should be considered while conducting the risk assessment, and include in the risk assessment report to enable reviewers to establish a contextual sense of how the facility relates to other facilities.

Recommended information for the report includes: READ SLIDE



This slide shows an example of a plot plan. The plot plan shows the facility boundary and the physical location of buildings and their relative position to one another and the combustion unit.

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Waste Identification


- Identifying general waste characteristics
 - Waste or feed stream analysis plans
 - Data from previous testing and/or permit applications
- Identifying specific waste characteristics
 - Description of the waste feed streams burned during the stack sampling
 - Chemical composition and physical properties
 - Description of why it is a representative or worst-case waste



Wastes burned in the combustion unit should be identified. This type of information can be obtained from waste or feed stream analysis plans and data from previous testing and or permit applications.

Waste characteristics must be identified and the waste stream burned during the CPT should be described, including:

- chemical composition
- physical properties
- and an explanation of why it is a representative or worst-case waste


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Identification of COPCs

- No universal list
 - COPCs at one facility may differ from another
 - Influenced by composition of waste stream
- EPA suggested COPCs
 - Compounds understood to routinely contribute to risk from combustion facilities
 - Dioxins/Furans
 - Polycyclic Aromatic Hydrocarbons (PAHs)
 - Polychlorinated Biphenyls (PCBs)
 - Nitroaromatics
 - Phthalates
 - Metals



Compounds of potential concern (COPCs) are those compounds evaluated throughout the risk assessment. There is no universal list of COPCs, because a compound that's a COPC for one combustor may not be a COPC for another combustor.


Generally speaking, COPCs include metals, products of incomplete combustion (PICs), and/or reformation products. Compounds that routinely contribute to risk from combustion facilities include: READ SLIDE

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Identification of COPCs (Cont)

- Same COPCs tend to drive risk for *most* SSRAs
 - Human Health SSRAs
 - Hg and chromium
 - PAHs if care is not taken to get lowest detection limits possible
 - Phthalates if care is not taken to rule out laboratory contamination and use uptake factors based on reliable Kow studies
 - Ecological SSRAs
 - Bioaccumulative metals
 - e.g. Al, Cu, Zn




The last 15 years has demonstrated that the same COPCs tend to contribute risk for most facilities. For human health risk assessments, those include:

- Hg and chromium
- PAHs if care is not taken to get lowest detection limits possible
- Phthalates if care is not taken to rule out laboratory contamination and use uptake factors based on reliable Kow studies

For ecological risk assessments, they include metals, such as:

- aluminum
- copper and
- zinc


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Estimation of Stack Emission Rates for Existing Sources

- Stack test data
 - Lower of:
 - Test average plus two standard deviations or
 - Maximum single test result
- SSRAs initially assume the maximum test value represents a value characterizing 30 years of continuous plant operation, with no credit taken for operational “down time”.
 - Review of operational data are typically undertaken to determine an “upset adjustment factor”.




The next step in the process is estimation of stack emissions. For existing sources, the general expectation is that emission rates will be based on direct stack measurements from regulatory performance tests since permitting agencies generally require a performance tests before granting a permit to burn hazardous waste.

For the risk assessment, the lower of the test average + 2 SD or the maximum measured result is typically used.

In most cases, it is initially assumed that the maximum test value represents a value characterizing 30 years of continuous plant operation, with no credit taken for operation down time.


Operational data are typically undertaken to determine an “upset adjustment factor”

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Estimation of Stack Emission Rates for Units Not Yet Built

- Data "in lieu of" testing which may include:
 - Stack test data from a similar combustor;
 - Estimates of stack emissions from waste characterization data and conservative SRE/DRE assumptions;
 - Other valid sources of information (e.g., design specifications).



For units that have yet to be built, data in lieu of testing may be submitted. This may include: READ SLIDE

Permitting authorities generally consider this type of data on a case-by-case basis.

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Estimation of Fugitive Emission Rates

- Fugitive emissions are typically associated with the release of compounds or pollutants from leaks in the combustion chamber (e.g., “puffs”); tanks, valves, flanges, and other material handling equipment used in the storage and handling of RCRA hazardous wastes as part of the combustion process.
 - (1) Identify equipment to evaluate as a fugitive emission source(s);
 - (2) group equipment, as appropriate, into a combined source; and
 - (3) estimate compound-specific emission rates for each source.



Fugitive emissions are typically associated with the release of compounds or pollutants from leaks in the combustion chamber (e.g., “puffs”); tanks, valves, flanges, and other material handling equipment used in the storage and handling of RCRA hazardous wastes as part of the combustion process.

The following series of steps are recommended to quantitatively estimate VOC emissions that occur as a result of equipment leaks:

- (1) identify equipment to evaluate as a fugitive emission source(s);
- (2) group equipment, as appropriate, into a combined source; and
- (3) estimate compound-specific emission rates for each resulting source.

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Example Fugitive Emissions Calculation

1	2	3	4	5	6		7	8	9	10
					Equipment Emission Factors					
Fugitive Emission Source	Waste Stream	Type of Waste Stream In Service	Equipment Type	Number of Each Equipment Type Per Waste Stream	(kg/hr)	(g/sec)	Total VOC Weight Fraction	Operational Time Period of Equipment (days)	Total VOC Emissions Rate by Equipment (g/sec)	Total Fugitive Emission Rate (g/sec)
Waste Feed Storage Area	Process A Wastes	Light Liquid	Pumps	3	0.01990	0.00553	0.9	180	0.01493	0.14926
		Light Liquid	Valves	70	0.00403	0.00112	0.9	180	0.07056	
		Light Liquid	Connectors	30	0.00183	0.00051	0.9	180	0.01377	
		Light Liquid	Tank WST-1	1	--	--	0.9	180	0.02	
		Light Liquid	Tank WST-2	1	--	--	0.9	180	0.03	
	Process B Wastes	Heavy Liquid	Pumps	2	0.00862	0.00239	0.6	180	0.00287	0.06857
		Heavy Liquid	Valves	75	0.00023	0.00112	0.6	180	0.0504	
		Heavy Liquid	Connector	50	0.00183	0.00051	0.6	180	0.0153	
		Heavy Liquid	Tank WST-1	1	--	--	0.6	0	0	
		Heavy Liquid	Tank WST-2	1	--	--	0.6	0	0	

The Average Emission Factor Approach (AEFA) approach is most commonly used to estimate fugitive VOC emissions because other available approaches need screening data collected using a portable monitoring device, which is usually limited or non-existent.

In the AEFA method, equipment is grouped by waste streams of similar characteristics and VOC composition. Information needed to estimate fugitive emission rates using the AEFA method includes:

- 1) Type of waste stream associated with each equipment type
- 2) Number of each equipment type associated with each waste stream
- 3) Total VOC weight fraction of each waste stream
- 4) Weight fraction of each VOC in each waste stream and
- 5) Operational time period of equipment

SOCMI Average emission factors for equipment type and service combinations are typically used. To calculate the total VOC emissions rate for a specified equipment type, the equipment emission factor is multiplied by the total VOC weight fraction and the number of each equipment type per waste stream.

The total fugitive emission rate for the waste stream is calculated by summing the total VOC emission rates for each equipment type.

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Example Speciated Fugitive Emission Calculations

1	2	3	4	5	6
Fugitive Emission Source	Waste Stream	Waste Stream Composition	Weight Fraction of Each VOC In Waste Stream (%)	Total Fugitive Emission Rate (g/sec)	Speciated Fugitive Emissions (g/sec)
Waste Feed Storage Area	Process A Wastes	Acetaldehyde	0.20	0.14926	0.0030
		Acetonitrile	0.25		0.0037
		2-Nitropropane	0.25		0.0037
		Nitromethane	0.20		0.0030
	Process B Wastes	Acetaldehyde	0.20	0.06857	0.0137
		Acetonitrile	0.10		0.0069
		Methanol	0.20		0.0137
		Propionitrile	0.05		0.0034


Speciated fugitive emissions are then calculated by multiplying the weight fraction of each VOC in the waste stream and the total fugitive emission rate for the waste stream. This speciated emission rate is the emission rate used in the risk assessment.

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Air Dispersion & Deposition Modeling

- Purpose: Estimate unitized air impacts and deposition rates to support the SSRA.
 - AERMOD model (Version 04300) run in accordance with USEPA Guideline on Air Quality Models (GAQM)
- Gather source data (stack height, dimensions, location, etc.)
- Establish receptor grid
 - Cartesian receptor grid
 - 100 meter (m) spaced receptors from the fence-line out to three kilometers (km)
 - 500 m spaced receptors beyond 3 km out to 10 km
 - Facility fence line delineated by discrete receptors placed at 50 m intervals along the property boundary line
- Obtain meteorological data
- Prepare input files
- Run AERMOD
 - Results serve as the first in a series of inputs to the risk assessment model 


The 5th step is air dispersion and deposition modeling. It is during this step that unitized air concentrations and deposition rates to support the SSRA are calculated.

There are 4 air models in current regulatory use. ISCST3 is the Model most used by regional, state and local agencies, however, AERMOD is proposed to replace ISCST3 as the recommended air quality model for most regulatory applications. AERMOD has several improvements over ISCST3, but less regulatory acceptance.

Steps involved in conducting air modeling include:

- 1) Gathering source data, such as stack height, dimensions, location, etc.
- 2) Establish a receptor grid
- 3) Obtain meteorological data
- 4) Prepare input files and
- 5) Run the model


Standard procedure is to set up a cartesian receptor grid with 100 meter (m) spaced receptors from the fence-line out to three kilometers (km), 500 m spaced receptors beyond 3 km out to 10 km. The facility fence line is delineated by discrete receptors placed at 50 m intervals along the property boundary line.

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Human Health Exposure Assessment

- Scenarios
 - Current and reasonable potential future:
 - Resident
 - Adult and child
 - Farmer
 - Adult and child
 - Fisher
 - Adult and child




At this point, the steps in the process diverge for human health and ecological SSRAs. When conducting a human health SSRA, the next step is the exposure assessment.

The first step in the exposure assessment is identifying exposure scenarios. Standard exposure scenarios evaluated in SSRAs for combustion units include current and future:

- 1) Residents
- 2) Farmers
- 3) Fishers

These scenarios are intended to be appropriate for a broad range of situations, rather than to represent actual scenarios.


A receptor is defined as a human being potentially exposed to COPCs emitted to the atmosphere from a hazardous waste combustion facility. Both adults and child receptors are evaluated for each scenario

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Human Health Exposure Assessment

- Chronic Pathways
 - Inhalation of vapors and particulates
 - Incidental ingestion of soil
 - Ingestion of homegrown produce
 - Ingestion of homegrown meat and dairy products (farmer only)
 - Ingestion of fish (fisher only)
- Acute Pathway
 - Inhalation of vapors and particulates




An exposure “pathway” is the course a chemical takes from its source to the person being exposed.

Receptors come into contact with COPCs via two primary exposure routes when the source of contaminants is a combustion unit: either directly—via inhalation; or indirectly—via COPC deposition and subsequent ingestion of water, soil, vegetation, and animals that have been contaminated by COPCs through the food chain.

Both long-term or chronic and short-term or acute exposures are evaluated in SSRAs.

Standard chronic exposure pathways evaluated include: READ SLIDE


The only short-term exposure pathway evaluated is inhalation because it represents the most significant short-term exposure potential and is the only pathway for which short-term toxicity factors are readily available.

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Waterbody & Watershed Inputs

- Average Annual Recharge
- Average Annual Runoff
- Ambient Temperature
- Average Wind Speed
- Surface Area of Contaminated Area
- Impervious Watershed Area
- Water Body Surface Area
- Average Volumetric Flow Rate
- Depth of Water Column
- USLE Rainfall Factor
- Current Velocity
- Wind Velocity at 10m Above Surface



The next step is to estimate media concentrations. For waterbodies selected as potential sources for drinking water and/or fish ingestion exposure pathways, watershed and waterbody inputs will need to be gathered.

This slide shows specific water body and watershed parameters that must be input into the fate and transport equations in order to estimate water column concentrations.

Exposure Pathway	Media Concentrations	Input
Soil Ingestion	Soil may become contaminated by emissions through direct deposition onto the soil. The soil equation includes a loss term which accounts for the loss of contaminant from the soil after deposition by several mechanisms, including leaching, erosion, runoff, degradation, and volatilization	<ol style="list-style-type: none"> 1. Emission rates 2. Modeled vapor phase air concentration, wet deposition from vapor phase, dry deposition from particle phase, and wet deposition from particle phase 3. Soil concentration due to deposition
Consumption of aboveground produce	Produce may become contaminated by emissions through direct deposition onto the plant, direct uptake of vapor phase contaminant, and root uptake of contaminants deposited on the soil	<ol style="list-style-type: none"> 1. Emission rates 2. Modeled vapor phase air concentration, wet deposition from vapor phase, dry deposition from particle phase, and wet deposition from particle phase 3. Soil concentration due to deposition 4. Air-to-plant biotransfer factors
Consumption of Animal Products	Animal tissue may be contaminated through ingestion of contaminated produce and soil by livestock or wildlife.	<ol style="list-style-type: none"> 1. Emission rates 2. Modeled vapor phase air concentration, wet deposition from vapor phase, dry deposition from particle phase, and wet deposition from particle phase 3. Soil concentration due to deposition 4. Forage and silage concentrations 5. Beef concentration due to plant and soil ingestion by cattle 6. Milk concentration due to plant and soil ingestion by cows 7. Deer and turkey meat concentrations due to plant and soil ingestion
Consumption of Water and Fish	Contaminant concentrations in a waterbody are partitioned between dissolved phase, suspended sediment, and benthic sediment. Contaminant concentrations in fish are calculated from the contaminant concentrations in the waterbody.	<ol style="list-style-type: none"> 1. Soil concentration averaged across the watershed 2. Total contaminant load to the waterbody due to runoff, soil erosion, and direct deposition 3. Dissolved water concentration 4. Total water column concentration 5. Sediment concentration 6. Bioconcentration and/or bioaccumulation factors 7. Biota-to-sediment accumulation factors
Direct Inhalation (human health only)	Air concentration of a pollutant based on modeling runs for the vapor phase and the particle phase	<ol style="list-style-type: none"> 1. Vapor phase air concentration 2. Particle phase air concentration 3. Fraction of contaminants in vapor phase

This table summarizes important considerations that go into identifying exposure pathways, estimating media concentrations, and developing pathway-specific risk estimates.

For example, soil may become contaminated by emissions through direct deposition onto the soil. The soil equation includes a loss term which accounts for the loss of contaminant from the soil after deposition by several mechanisms, including leaching, erosion, runoff, degradation, and volatilization.


Inputs required to estimate soil concentrations due to deposition include:

1. Emission rates
2. Modeled vapor phase air concentration, wet deposition from vapor phase, dry deposition from particle phase, and wet deposition from particle phase

This estimated soil concentration is then used to estimate exposure via soil ingestion.

Likewise, produce may become contaminated by emissions through direct deposition onto the plant, direct uptake of vapor phase contaminant, and root uptake of contaminants deposited on the soil. Inputs required to estimate concentrations in plants include:


1. Concentration in soil due to deposition and
2. Plant uptake factors

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Risk Characterization (human health)

- Final step
 - Combines:
 - Exposure media concentrations
 - Assumptions on human intake
 - Toxicity
 - Calculation of:
 - Cancer risk
 - Non-cancer quotients and hazard index
 - Description of uncertainties



The final step in the human health risk assessment is “Risk Characterization”. This involves combining the exposure quantities and the toxicity benchmarks to calculate the excess lifetime cancer risks (risk) and noncancer hazards (hazard) for each of the pathways and receptors identified. Risks (and hazards) are then summed for each receptor, across all applicable exposure pathways, to obtain an estimate of total individual risk and hazard.


Risk characterization also includes an uncertainty analysis.

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Estimation of Cancer Risk

- Estimated Lifetime Cancer Risk
 - Oral Pathway
 - Lifetime Average Daily Dose x Cancer Slope Factor
 - Inhalation Pathway
 - Air Concentration x Inhalation Unit Risk Factor
 - Total Estimated Lifetime Cancer Risk
 - Summation of Cancer Risks across all chemicals and pathways




Risk from exposure to combustor emissions is the probability that a human receptor will develop cancer, based on a unique set of exposure, model, and toxicity assumptions. EPA uses oral cancer slope factors (CSF) or inhalation unit risk (IUR) factors in risk assessments to estimate the probability of an individual developing cancer as a result of exposure. EPA recommends EPA-derived or reviewed health benchmarks (URFs and CSFs), which are published in an online database (IRIS) that anybody can access. However, for numerous compounds, a complete set of inhalation and oral EPA-derived health benchmarks are not available. In such cases, EPA has calculated the health benchmarks presented in the HHRAP based on EPA-derived benchmark values. EPA derives and publishes the slope factors and unit risk factors.

Potential incremental ("excess") lifetime cancer risks via the oral pathway is calculated for each receptor by multiplying the appropriate CSF by the site-specific exposure dose level determined for each of the exposure scenarios as described previously. For the inhalation pathway it is calculated by multiplying the appropriate IUR factor by the site-specific air concentration.

To estimate the total lifetime cancer risk, cancer risk estimates are summed across all pathways and COPCs for an individual receptor.


The cancer slope factor

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Estimation of Non-Cancer Hazard

- Hazard Quotient
 - Oral Pathway
 - Chronic Average Daily Dose ÷ Oral Reference Dose
 - Inhalation Pathway
 - Air Concentration ÷ Inhalation Reference Concentration
- Hazard Index
 - Summation of Hazard Quotients




For non-carcinogens, it is assumed that there is a level of exposure below which no adverse effects will be observed (i.e., an intrinsically safe concentration). EPA-derived or reviewed RfDs and RfCs should be used.

The default approach used by EPA to assess the potential for health effects associated with a nonlinear or threshold relationship involve comparing an estimate of ingested exposure to an RfD for oral exposures and comparing an estimated chemical-specific air concentration to the RfC for direct inhalation exposures.

An RfD is a daily oral intake rate that is estimated to pose no appreciable risk of adverse health effects, even to sensitive populations, over a 70-year lifetime. Similarly, an RfC is an estimated daily concentration of a chemical in air that poses no appreciable risk of adverse health effects, even to sensitive populations.


As with carcinogenic chemicals, a receptor might be exposed to multiple chemicals associated with noncancer health effects. Therefore, EPA recommends calculating the total chronic hazard for each exposure pathway by summing all HQs to arrive at a HI for an individual receptor. This method assumes that the health effects of the various COPCs are additive. This method is a simplification of the HI concept because it doesn't directly consider the portal of entry associated with each exposure pathway (i.e. inhalation, or ingestion), nor does it consider the often unique toxic endpoints and toxicity mechanisms of the various COPCs. Therefore, if the HI exceeds the target HI goal, the HQs should be segregated by target organ.

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Putting Estimated Risk into Context


- Calculated potential health risks are put into context by comparing them with target risk levels.
- No firm agency values



Target levels are used to put estimate health risks into context.

Target levels are risk management-based and set by the permitting authority. As such, there are no firm agency values, although historically, a 1×10^{-5} cancer risk target and a HI target of 1 have most often been used.


Target values are not a discrete indicator of observed adverse effect. If a risk estimate falls below target levels, a regulatory authority may, without further investigation, conclude that a proposed action does not present an unacceptable risk. A risk estimate that exceeds these targets, however, would not, in and of itself, necessarily indicate that the proposed action is not safe or that it presents an unacceptable risk. Rather, a risk estimate that exceeds a target value triggers further careful consideration of the underlying scientific basis for the calculation.

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Target Risk and Hazard Levels

“Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 1×10^{-4} , and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts.”




Although decisions on what represents an acceptable target risk level is made by the regulating authority and can vary depending on the circumstances, READ SLIDE

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Target Cancer Risk

- To derive an acceptable level of risk for non-threshold chemicals, it is necessary to take a view about the acceptability of levels of additional risk (above background).
 - What is considered to be the “acceptable” level of risk varies amongst different organizations.
 - Usually between 1×10^{-6} and 1×10^{-4}
 - Most SSRAs for HWCs have used 1×10^{-5}
 - 9×10^{-5} reserved for exposures that may come from other background sources.



To derive an acceptable level of risk for carcinogens, it is necessary to take a view about the acceptability of levels of additional risk. What is considered to be the acceptable level of risk can vary over orders of magnitude (i.e., 1×10^{-2} and 1×10^{-6}) between different organizations (DEFRA, 2002b). Those target risk levels usually fall between 1×10^{-4} and 1×10^{-6} .


Most SSRAs for HWCs have used 1×10^{-5} as the target cancer risk, which has been set with the intent of maintaining a cumulative risk of no greater than 1×10^{-4} by reserving 9×10^{-5} for exposures associated with background.

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Target Non-Cancer Hazard Index


- Exposure to a chemical is not expected to cause significant adverse health effects if the ratio between intake concentration and non-cancer reference doses for all exposure pathways has a total value of 1 or less.
 - 75% of the hazard index (HI) ratio is reserved for exposures that may come from other background sources.
 - Remaining HI = 0.25 serves as an initial screening benchmark for exposures that may be associated with facility operations.
 - Unless further effort is undertaken to better understand the current and future background conditions, and their relationship to facility emissions.
 - If the resulting summation exceeds 0.25, the HI analysis should be re-examined and refined, such that only those chemicals exhibiting the same or similar toxicity endpoints (i.e., target organs) are summed.



For noncarcinogens, exposure to a chemical is not expected to cause adverse effects as long as the intake or exposure is less than the RfD or the air concentration is less than the RfC.

Again, the target HI that represents an acceptable hazard is established by the regulating entity. However, for most SSRAs for HWC, a target HI of 0.25 has been used. This HI has been set based on similar logic to that used in setting the target cancer risk goal.

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Ecological Problem Formulation


- Exposure setting characteristics
 - Habitats
 - Terrestrial
 - Aquatic
 - Receptors
 - Plant and animal communities representative of habitat



The next few slides, are intended to guide us through a very general discussion on the conduct of ecological SSRAs for HWCs. If you recall the slide showing the various components of a SSRA indicating that the first 6 steps are the same for human health and ecological SSRAs. So the same procedures that were discussed previously for facility characterization, waste characterization, COPC identification, emission estimation, and estimation of media concentrations are used in ecological SSRAs as well. The point where ecological SSRAs diverge from human health SSRAs is in the Problem Formulation phase, although the Problem Formulation is similar to the Exposure Assessment phase of the human health SSRA.

Problem formulation establishes the exposure setting used as the basis for exposure analysis and risk characterization. Problem formulation includes:

- (1) characterization of the exposure setting for identification of potentially exposed habitats in the assessment area
- (2) development of food webs representative of the habitats to be evaluated
- (3) selection of assessment endpoints relevant to food web structure and function and
- (4) identification of measurement receptors (Section 4.4).


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Ecological Problem Formulation (Cont)

- Food web development
- Select assessment endpoints
- Identify measurement endpoints



Information obtained during exposure setting characterization should be used to develop one or more habitat-specific food web(s) that represent communities and guilds of receptors potentially exposed to emissions from facility sources, assessment endpoints and measurement endpoints.

An assessment endpoint is an expression of an ecological attribute that is to be protected.

A measurement endpoint is the measures used to evaluate “the response of the assessment endpoint when exposed to a stressor.


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Ecological Problem Formulation (Cont)

- Food web development
 - Group into feeding guilds
 - Organize by trophic level
 - Define dietary relationships
- Select assessment endpoints
- Identify measurement endpoints



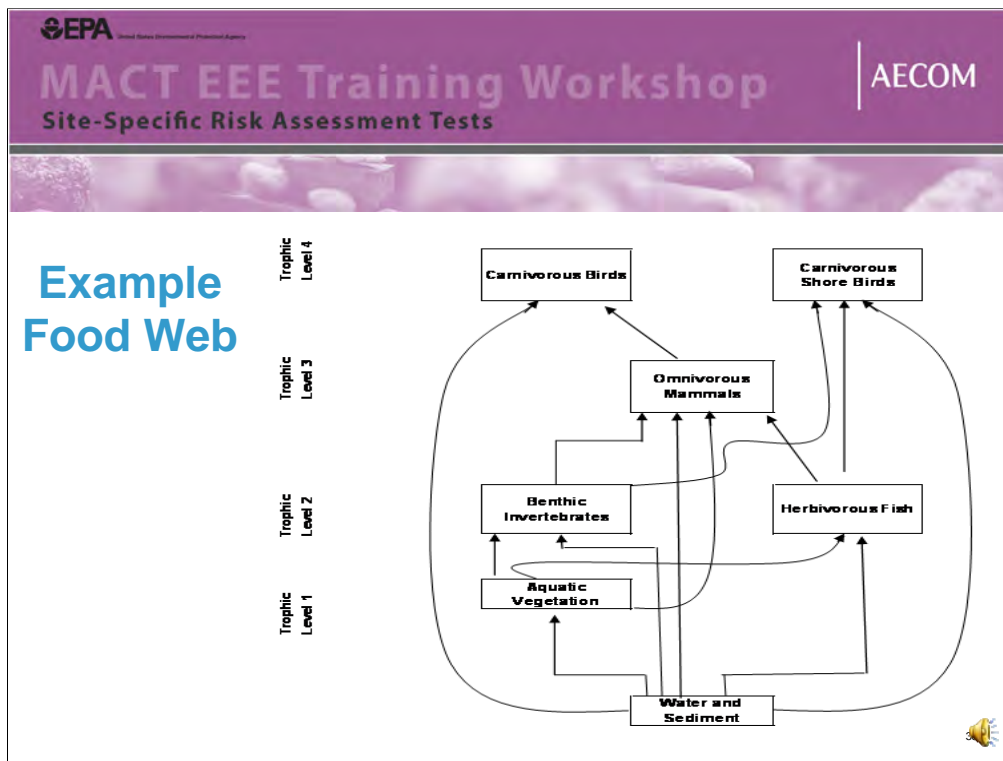
Food webs are interlocking patterns of food chains, representing transfer of energy from a food source (e.g., plants) to a series of organisms feeding on the source or on other organisms feeding on the food source. The importance of a food chain as an exposure pathway primarily depends on receptor dietary habits, the receptors in the food chain, and other factors including bioavailability. Therefore, the potentially exposed receptor community is grouped into feeding guilds.

The structure of a food web should be organized according to trophic level, which I will discuss in more detail on the next slide. But basically, a trophic level is one of the successive levels of nourishment in a food web or food chain. Once the food web is broken down into trophic levels, then the dietary relationships are defined.

The next step in Problem Formulation is selection of assessment endpoints, which is followed by selection of measurement endpoints. Assessment endpoints should be identified specific to each class-specific guild and community within each trophic level of the habitat-specific food web. Examples of community assessment endpoints include:

- Diversity or species richness
- Community composition
- Productivity
- Major food source for consumer
- Habitat for wildlife

Measures of effect are selected as: (1) toxicity values developed and/or adopted by federal or state agencies (e.g., ambient water quality criteria [AWQC], NOAA effects range low [ERL] values) for protection of media-specific communities, or (2) receptor-specific chronic no-observed-adverse-effects-levels (NOAELs) or their equivalent for ecologically relevant endpoints.



This slide shows an example generic food web defined by trophic level. The first trophic level (TL1) contains the primary producers or the green plants. These primary producers are also the source of food for members of the second trophic level (TL2). The second trophic level is often referred to as the primary consumers and is composed of animals that eat plants (herbivores) and animals that subsist on detritus (decaying organic matter) found in sediment and soil (detritivores). The third trophic level (TL3), contains both omnivores and carnivores. Omnivores are animals that eat both plant and animal matter, while carnivores eat primarily animal matter. The fourth trophic level (TL4), contains only carnivores and is sometimes referred to as the dominant carnivores. TL4 contains animals at the top of the food chain (e.g., raptorial birds). In a site-specific food web, animals present in the community to be protected would be listed in the web.

Although most organisms have a complex diet, it is generally assumed that the majority of their diet is composed of a limited number of prey items and, therefore, a limited number of feeding guild interactions occur.


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Analysis (ecological)

- Toxicity assessment
- Exposure assessment
 - Detailed assumptions in SLERAP
 - Equal vs. exclusive diet
 - Ingestion rates
 - Allometric equations
 - COPC bioconcentration factors
 - Food chain multipliers
 - Equations




Toxicity to community and class-specific guild measurement receptors is assessed using different approaches. This is because the available toxicity reference values (TRVs) used in risk characterization for lower trophic level communities are media specific; whereas TRVs for upper trophic level class-specific guilds are provided in terms of dose ingested.

Exposure assessment consists of quantifying exposure of a receptor to a COPC. For community measurement receptors (e.g., water, sediment, and soil communities), the exposure assessment consists of determining the safe COPC concentration in the media that the particular community inhabits. For class-specific guild measurement receptors, exposure is assessed by quantifying the daily dose ingested of contaminated media and/or organism (expressed as the mass of COPC ingested per kilogram body weight per day).

The complexity of the daily dose equation for class-specific guild receptors will depend on a number of things, including

- (1) the number of food items in a measurement receptor's diet
- (2) the trophic level of each food item and
- (3) the measurement receptor.

Detailed assumptions can be found in the SLERAP, although it is not currently recommended for use (not sure why) until it undergoes revision.

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Estimation of Ecological Screening Quotient

$$ESQ = \frac{EEL}{TRV}$$

Where:

<i>ESQ</i>	=	<i>Ecological Screening Quotient</i>
<i>EEL</i>	=	<i>Estimated Exposure Level</i>
<i>TRV</i>	=	<i>Toxicity Reference Value</i>



This slide shows the generic equation used to estimate risk for class-specific guild receptors. It is very similar to the equation used to estimate noncarcinogenic risk for humans. Essentially the estimated exposure level is compared to a toxicity reference value. If the exposure level is below the TRV, then it can be generally concluded that the exposure does not pose a risk.

The ESQ that represents an acceptable level of risk, however, would be the decision of the regulating authority.