

REINHOLD ENVIRONMENTAL Ltd.



## **2016 APC-Wastewater Round Table & Expo Presentation**

July 18 & 19, 2016 in Dearborn, MI / Hosted by DTE Energy

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# MATS, CCR, & ELG Perspective for the Fate of Trace Heavy Metals in Coal Plant Gas, Liquids and Solid Streams

**2016 APC – Wastewater Round Table**

**Training Class 10**

Dearborn, Michigan

July 18, 2016

Chris Wedig

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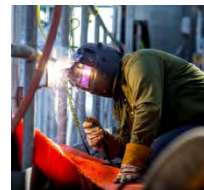
William Frazier





This press release contains forward-looking statements regarding CB&I and represents our expectations and beliefs concerning future events. These forward-looking statements are intended to be covered by the safe harbor for forward-looking statements provided by the Private Securities Litigation Reform Act of 1995. Forward-looking statements involve known and unknown risks and uncertainties. When considering any statements that are predictive in nature, depend upon or refer to future events or conditions, or use or contain words, terms, phrases or expressions such as "achieve," "forecast," "plan," "propose," "strategy," "envision," "hope," "will," "continue," "potential," "expect," "believe," "anticipate," "project," "estimate," "predict," "intend," "should," "could," "may," "might" or similar forward-looking statements, we refer you to the cautionary statements concerning risk factors and "Forward-Looking Statements" described under "Risk Factors" in Item 1A of our Annual Report filed on Form 10-K filed with the SEC for the year ended December 31, 2015, and any updates to those risk factors or "Forward-Looking Statements" included in our subsequent Quarterly Reports on Form 10-Q filed with the SEC, which cautionary statements are incorporated herein by reference.

- Introduction
- Overview Process Discussion of Fate of Trace Heavy Metals
- Mercury Air Toxics Standards (MATS)
- Steam Electric Power Generating Effluent Guidelines (ELG)
- Disposal of Coal Combustion Residuals (CCR)
- Summary
- Additional Information Slides





# Introduction

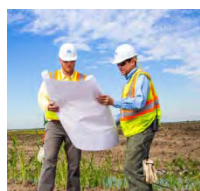
- There are numerous regulations and guidelines that impact coal-fired power plants
- This workshop will provide an overview of three regulatory programs
  - Mercury Air Toxics Standards (MATS)
  - Steam Electric Power Generating Effluent Guidelines (ELG)
  - Disposal of Coal Combustion Residuals (CCR)
- The workshop will focus on the fate of trace heavy metals in coal-fired power plant gas, liquids, and solids streams from the perspective of MATS, ELG, & CCR





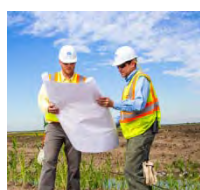
# Major Regulatory Programs Affecting Fossil Fuel-Fired Power Plants

- Air quality programs
  - **Mercury and Air Toxics Standards (MATS)**
  - Regional Haze Rule (mainly power plants in the Western U.S.)
  - Clean Power Plan (CPP) (existing power plants)
  - Carbon Standards (new power plants)
  - 2015 8-Hour Ozone National Ambient Air Quality Standard (NAAQS)
  - Proposed update to the Cross State Air Pollution Rule (CSAPR)
- Water quality programs
  - Clean Water Act Section 316(b) Rule
  - **Steam Electric Effluent Limitation Guidelines (ELG)**
- CCR Management and Disposal
  - **Coal Combustion Residuals (CCR) Rule**
- Other State/Federal regulatory activities





# Timeline of Some Major Regulatory Programs Affecting Electric Generating Units (EGUs) - Examples



Note: in addition, there are other major regulatory programs affecting EGUs (e.g., Regional Haze, WOTUS, NPDES, NSR, SIPs, permitting, etc.).

Sources: EPA

Source: Patricio Silver, Senior Analyst, System Planning, ISO New England, [ISO New England Environmental Update](#), November 3, 2015.

Note: Additional text added to update.



# Overview Process Discussion of Fate of Trace Heavy Metals

There are several definitions for trace heavy metals with regard to coal-fired power plants and other topics (e.g., trace heavy metals addressed in regulations, trace metals with specific gravity greater than ~ 4 to 5, or less precise definitions, etc.).

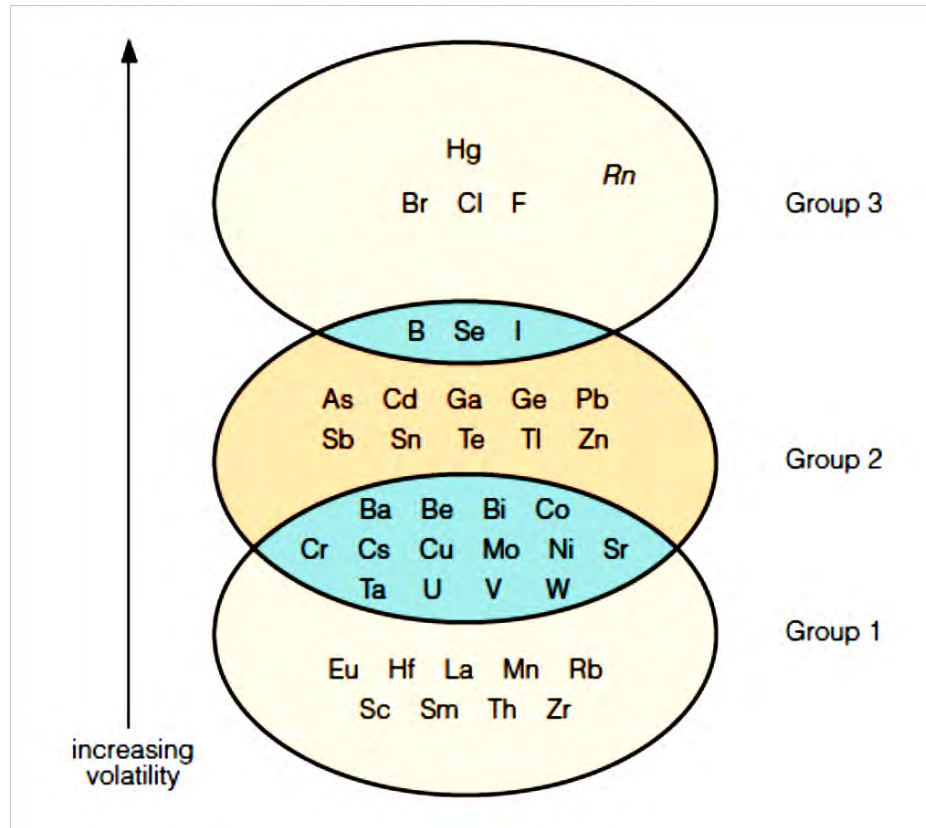
Examples of light and trace heavy metals addressed in the combined topics of MATS/ELG/CCR are as follows:

Antimony (Sb)	Lead (Pb)
Arsenic (As)	Lithium (Li)
Barium (Ba)	Manganese (Mn)
Boron (B)	Mercury (Hg)
Beryllium (Be)	Nickel (Ni)
Cadmium (Cd)	Radium 226 & 228 (Ra)
Calcium (Ca)	Selenium (Se)
Chromium (Cr)	Thallium (Tl)
Cobalt (Co)	Other metals

Notes: the combined topics of MATS, ELG, and/or CCR address a wide range of issues including various chemical elements and compounds, such as anions, cations, heavy metals, light metals, inorganic and organic compounds, other substances, plus chemical and physical parameters of various streams from coal-fired power plants. Thus, heavy metals is just one subject addressed.



## Example of trace element classification during coal combustion



Trace elements during coal combustion can distribute (report) to the flue gas, bottom ash, and flyash streams, which are then treated by the plant AQCS and ELG/CCR material handling & environmental systems. Element enrichment factors apply to flyash and bottom ash concentration values compared to coal element concentration values, due to element volatility and other chemical/physical parameters during and after combustion.

Source: Figure provided by IEA with permission.



## Analytical Sampling Methods for EPA ELG Sampling Program

Parameter	Method Number
<b>Classicals</b>	
Biochemical oxygen demand (BOD <sub>5</sub> )	SM 5210 B
Chemical oxygen demand (COD)	EPA 410.4
Total suspended solids (TSS)	SM 2540 D
Total dissolved solids (TDS)	SM 2540 C
Sulfate	EPA 300.0
Chloride	EPA 300.0
Ammonia as nitrogen	EPA 350.1
Nitrate-nitrite as nitrogen	EPA 353.2
Total Kjeldahl nitrogen (TKN)	EPA 351.2
Total phosphorus	EPA 365.1
Total cyanide	SM 4500 CN E
<b>Total and Dissolved Metals</b>	
Mercury	EPA 1631E
Hexavalent chromium (dissolved only)	EPA 218.6
Antimony, arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and vanadium	EPA 200.8 with collision cell
Aluminum, barium, beryllium, boron, calcium, cobalt, iron, magnesium, manganese, molybdenum, sodium, tin, titanium, and zinc	EPA 200.7

Source: EPA – Technical Development Document for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category, dated September 2015.



The physical/chemical composition, oxidation state, speciation, partitioning, enrichment factor, distribution, associated chemical compounds, and disposition of trace heavy metals and other elements & materials within a coal-fired power plant depends on a variety of parameters:

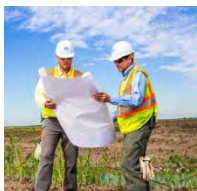
- Coal (e.g., coal type & composition, coal additives)
- Co-firing fuels (if employed)
- Boiler Type (e.g., PC, AFB, IGCC), Fuel Combustion Configuration, Ash Handling Systems
- Air Quality Control System (AQCS) and Reagents/Byproducts
- MATS Compliance Technologies and Reagents/Byproducts
- ELG Compliance Technologies and Reagents/Byproducts
- CCR Compliance Methods
- Other Factors



A variety of parameters influence the fate of trace heavy metals, below are a few examples for selected trace heavy metals (pulverized coal).

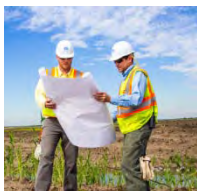
■ **Trace Mercury (PC unit)**

- Trace mercury in coal fuel (as inorganic/organic compounds)
- flue gas elemental  $\text{Hg}^0$  , oxidized  $\text{Hg}^{+2}$  , and particulates
- oxidized by coal fuel additives during combustion
- oxidized by SCR catalyst
- captured by adsorbents or absorbents (e.g., ACI, AS)
- fly ash captured by ESP/fabric filter systems
- captured by WFGD or DFGD systems
- WFGD Hg re-emission inhibitor additive, pH, ORP,  $\text{SO}_3^{-2}$ , etc.
- precipitated as solids in WWT systems (e.g., co-precipitated solids, inorganic sulfide or organo-sulfide solids)
- in solid material discharged from ZLD treatment systems
- other

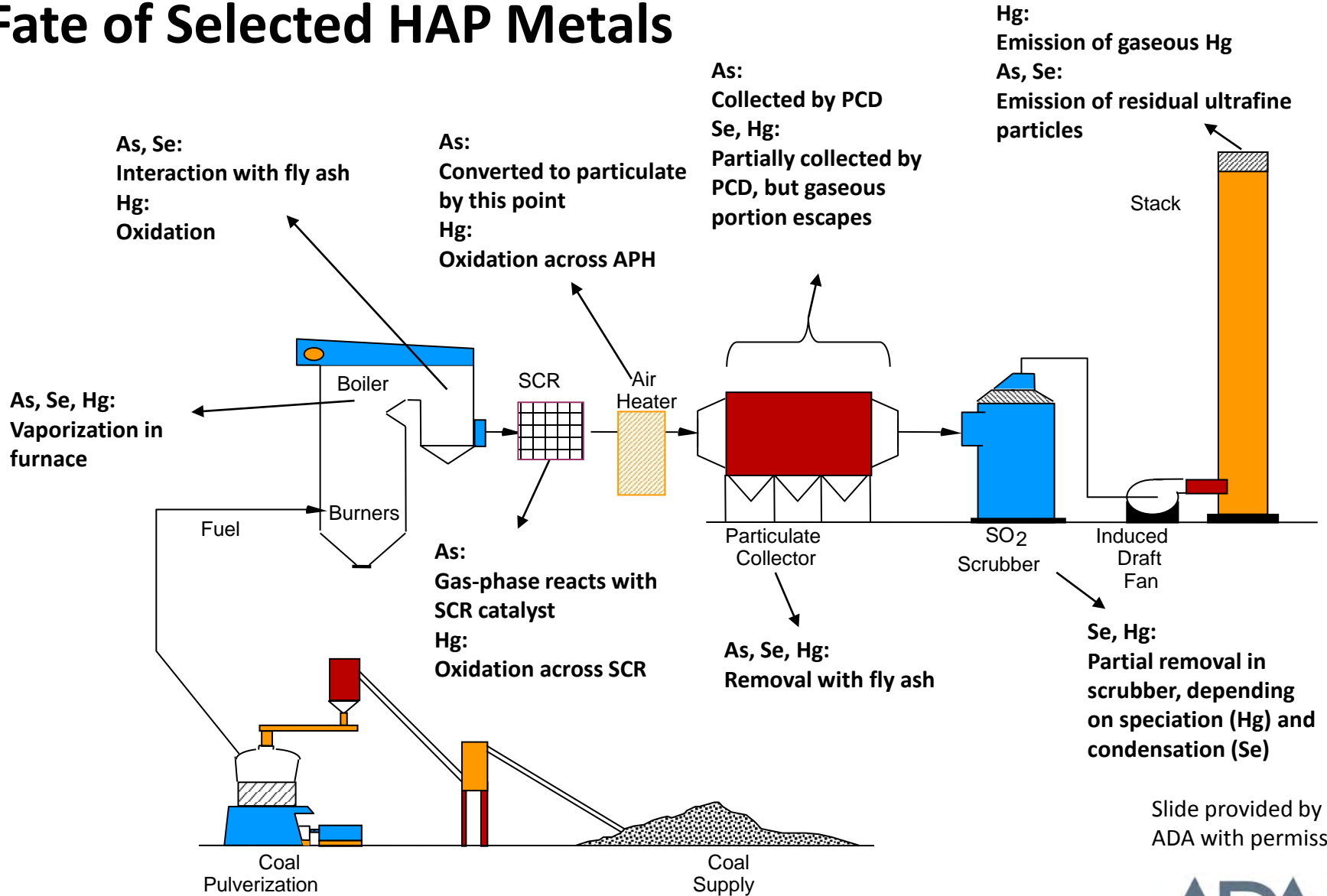


■ **Trace Selenium (PC unit)**

- Trace selenium in coal fuel (as inorganic/organic compounds)
- flue gas elemental  $\text{Se}^0$  , oxidized selenite  $\text{Se}^{+4}$  , oxidized selenate  $\text{Se}^{+6}$  and particulates
- fly ash captured by ESP/fabric filter systems
- captured by WFGD or DFGD systems
- WFGD parameters (e.g. ORP, pH, TDS metals, additives, etc.)
- removed in biological WWT systems
  - Selenate  $\text{SeO}_4^{-2}$  → Selenite  $\text{SeO}_3^{-2}$  →  $\text{Se}^0$  (insoluble solids)
- in solids material discharged from ZLD treatment systems
- other



# Fate of Selected HAP Metals

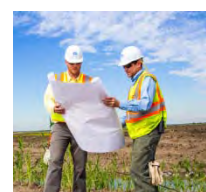


Slide provided by ADA with permission

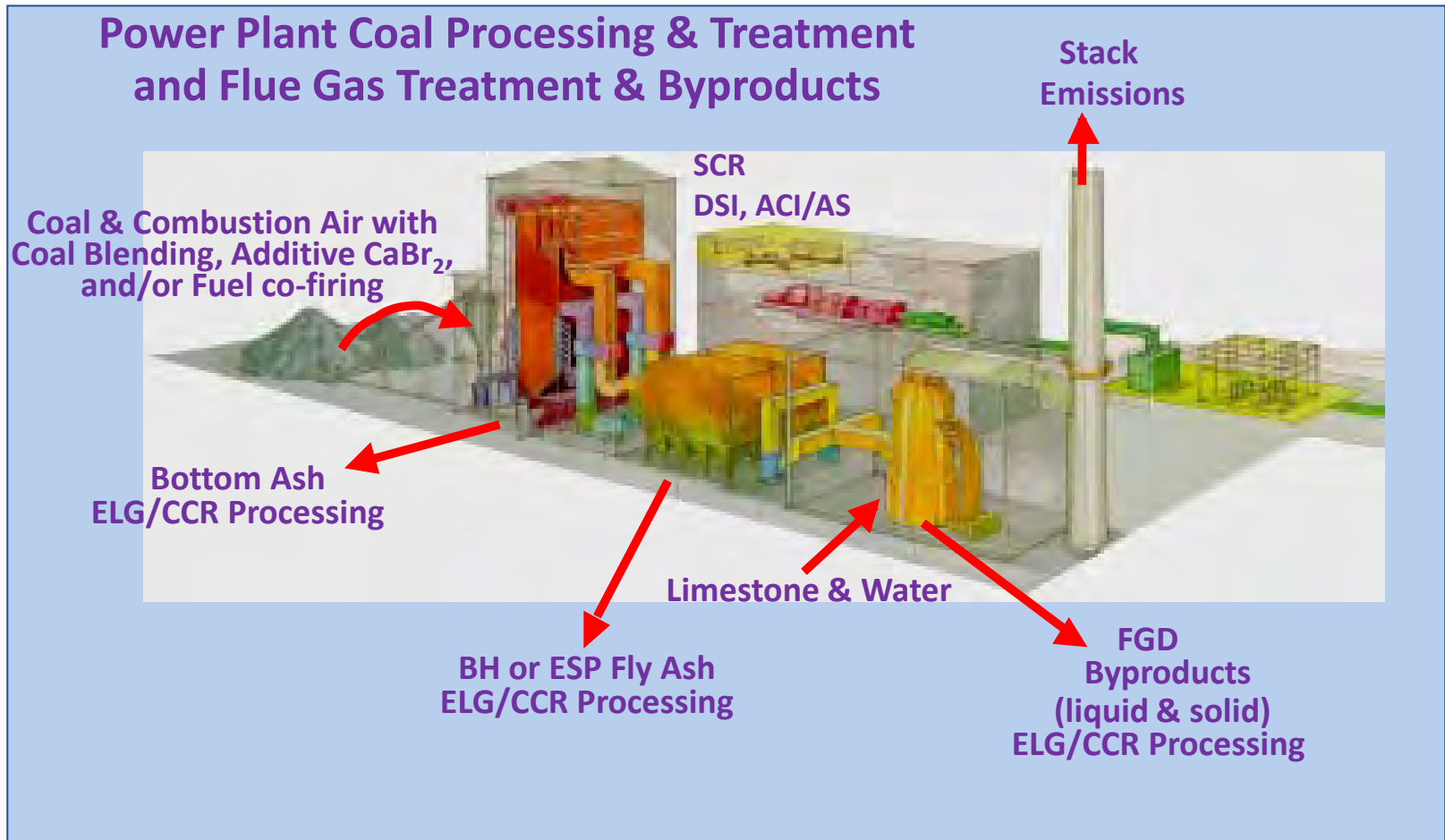
The overall dynamic mass balance for trace heavy metals at a coal-fired power plant is as follows

- **In – Out = Accumulation**

Notes: the combined topics of MATS, ELG, and/or CCR address a wide range of issues including various chemical elements and compounds, such as anions, cations, heavy metals, light metals, inorganic and organic compounds, other substances, plus chemical and physical parameters of various streams from coal-fired power plants. Thus, heavy metals is just one subject addressed.



## Pulverized Coal-Fired Power Plant – Fuel & AQCS - Examples



Dynamic Mass & Energy Balance of Power Plant Streams  
 $\text{In} - \text{Out} = \text{Accumulation}$

Examples of potential mass balance streams (input, annual basis) for a generic pulverized coal fired power plant is as follows

## Potential Mass Balance Input Streams

- Fuel – coal (as primary fuel) plus ignitor fuels
- Fuel Combustion air
- Coal additives (Hg oxidation, Se control, As control to protect SCR)
- SCR or SNCR reagent (NH<sub>3</sub> or urea for NO<sub>x</sub> reduction)
- Dry Sorbent Injection (Trona or hydrated lime for SO<sub>3</sub> control)
- Activated Carbon or Amended Silicate Injection (for Hg reduction)
- Makeup Water for FGD system (fresh or recycle water)
- FGD reagent for SO<sub>2</sub> reduction (limestone, DBA additive, lime, ammonia, etc.)
- FGD Hg re-emission inhibitor additive
- WFGD Oxidation Air (gypsum)
- Reagents & material used in FGD Physical/Chemical WWTS
- Reagents & material used in biological WWTS
- Reagents used in evaporator/crystallizer WWTS
- Pozzolanic reagents used in flyash/FGD brine/FGD sludge stabilization WWTS
- Water used for bottom ash transport
- Water used for flyash transport
- Water and/or reagents used for plant maintenance & cleaning
- Water and/or reagents used for dust suppression control
- Reagents used for landfill leachate treatment
- Other potential streams



Examples of potential mass balance streams (generated, annual basis) for a generic pulverized coal fired power plant is as follows:

## Potential Mass Balance Generated (output) Streams

- Flyash (ESP or fabric filter)
- Bottom ash (boiler)
- Other fuel solids (econ ash & mill rejects)
- Spent SCR catalyst (disposal or regen)
- Spent activated carbon or amended silicate solids (e.g. with flyash)
- Spent DSI/WSI solids (spent Trona or hydrated lime, SBC, with flyash)
- FGD byproducts (e.g. gypsum, SDA/CDS solids, sludge, NH<sub>3</sub> based fertilizer, H<sub>2</sub>SO<sub>4</sub>, etc.)
- FGD chloride purge blowdown (FGD CPS)
- Spent SPC modules (Hg control)
- Miscellaneous plant liquid & solid streams
- Stack flue gas
- WWTS treated liquid effluent
- Solids from FGD Phys/Chem WWTS
- Solids from biological WWTS
- Solids from evaporator/crystallizer WWTS
- Solids from flyash/pozzolanic agent/FGD brine/FGD sludge stabilization WWTS
- Solids from spray dryer evaporator WWTS
- Liquid output from UF/RO WWTS
- Solids/waste water from maintenance cleaning
- Solids/liquids from landfill leachate treatment
- Solids sent to secure landfill
- Other potential streams





# Mercury Air Toxics Standards (MATS)

(overview, timeline, and issues related to trace heavy metals)

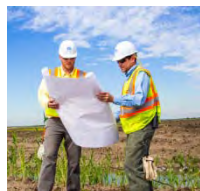
Some of the MATS key documents available from the EPA include

- Final Mercury and Air Toxics Standards (MATS) for Power Plants
- Regulatory Impact Analysis (RIA) for the Final Mercury and Air Toxics Standards
- MATS - Enforcement Response Policy
- Revised Technical Support Document: National-Scale Assessment of Mercury Risk to Populations with High Consumption of Self-caught Freshwater Fish In Support of the Appropriate and Necessary Finding for Coal- and Oil-Fired Electric Generating Units
- Memorandum: Emissions Overview: Hazardous Air Pollutants in Support of the Final Mercury and Air Toxics Standard
- Integrated Planning Model (IPM) Analysis of the Proposed MATS
- Technical Correction; Final Rule, published in 40 CFR Parts 60 and 63, Vol. 81, No. 66, April 6, 2016

There are numerous documents related to MATS available from the EPA at <https://www.epa.gov/mats>



- Focused on Hazardous Air Pollutants (HAPs)
- Affects Coal & Oil-Fired EGUs > 25 MW
  - New
  - Existing
- Technology Based Standards = Maximum Achievable Control Technology (MACT)
- Command and Control – No Emissions Trading
- Facility-Wide Averaging Allowed for Existing Units within the Same Subcategory
- Generally Recognized as Having Significant Influence on Recent Coal-Fired Power Plant Retirements



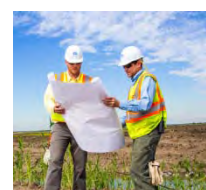
- April 14, 2016 - Consideration of Cost in the Appropriate and Necessary Finding for the MATS
- April 21, 2015 - Denial of Petitions for Reconsideration
- March 9, 2015 – E-Reporting Final Action
- November 7, 2014 – EPA updates the Startup and Shutdown Provisions of the MATS
- March 28, 2013 – EPA Updates the MATS for New Power Plants
- February 16, 2012 – Final MATS Rule Published in the Federal Register

Note that in June of 2015 the Supreme Court ruled that EPA had inappropriately ignored the costs of MATS. The Court allowed the MATS rule to remain in effect while EPA responded to its decision.

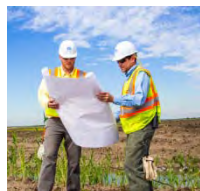
Note: This is a partial listing of EPA regulatory actions. For a more complete listing see <https://www.epa.gov/mats/regulatory-actions-final-mercury-and-air-toxics-standards-mats-power-plants>



- Categories of HAPs
  - Mercury (Hg)
  - Non-mercury metal HAPs
  - Acid gases (including HCl, HF, HCN)
  - Organic HAPs including dioxin/furans
- MATS requires compliance with individual mercury limits
- MATS allows compliance by individual non-Hg metal limits, a total non-Hg metals limit, or a filterable PM surrogate for total non-Hg metals
- Limits for HCl (surrogate for acid gases) or SO<sub>2</sub> emission rate limit (requires FGD and SO<sub>2</sub> CEMs)
- Work Practice Standards for Dioxin/Furans and Organic HAPs



- Compliance by April 6, 2015 unless a one-year extension was granted
  - Survey by the National Association of Clean Air Agencies (NACAA) indicated that 189 extension requests were made by affected power plants and 184 were granted
- In limited instances a two year compliance extension was possible to address specific documented reliability concerns.
  - EPA recently granted a two year extension to seven coal-fired units (total of 2,363 MW)





# MATS

Relationship to Issue of Trace

Heavy Metals at Coal Fired Power Plants

- Metal air toxics covered by MATS
  - Antimony (Sb)
  - Arsenic (As)
  - Beryllium (Be)
  - Cadmium (Cd)
  - Chromium (Cr)
  - Cobalt (Co)
  - Lead (Pb)
  - Manganese (Mn)
  - Mercury (Hg)
  - Nickel (Ni)
  - Selenium (Se)
- MATS requires compliance with individual mercury limits
- MATS allows compliance by individual non-Hg metal limits, total non-Hg metals limits, or filterable PM limits as a surrogate for total non-Hg metals





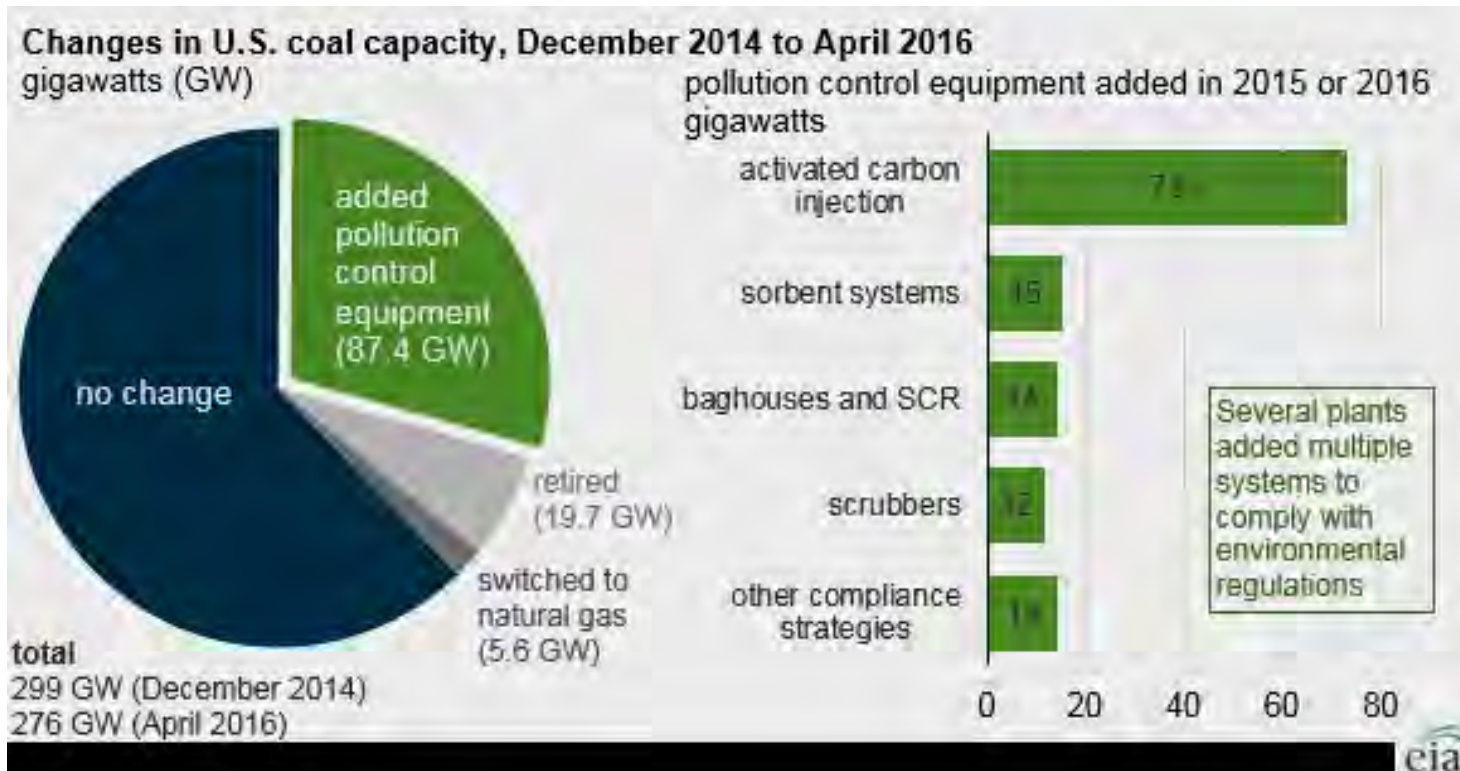
# MATS Examples of Trace Heavy Metal Removal and Fate in MATS Related Streams and Technologies – Coal Fired Power Plant

- PM Control (surrogate for non-Hg metal HAPs)
  - ESP retrofit or upgrades
  - Fabric filter retrofits or upgrades
  - Wet ESPs retrofit
- Acid Gas Control
  - Wet flue gas desulfurization (FGD) retrofits or upgrades
  - Dry FGD retrofits and/or upgrades
  - Dry sorbent injection (DSI) using sodium bicarbonate, Trona, or hydrated lime
  - Fuel Switching/Blending
- Mercury Control
  - Co-benefit reductions from NO<sub>x</sub>, SO<sub>2</sub>, PM AQCS controls (with/or without halogen addition on coal)
  - Activated carbon injection (ACI) or Amended Silicate injection (ASI)
  - Mercury Re-emission Inhibitor addition to FGD system
  - Gore modules addition to FGD system
- Natural gas conversion or co-firing with coal
- Numerous other AQCS technologies or concepts

Note: Selection of MATS compliance options should consider potential impacts on compliance with ELG, CCR.



## EIA Electricity Generator Data Show Power Industry Response to EPA Mercury Limits



Source: EIA (July 7, 2016), Annual Electric Generator Data (EIA-860) Early Release and Preliminary Monthly Electric Generator Inventory (EIA-860M).



# Steam Electric Power Generating Effluent Guidelines (ELG)

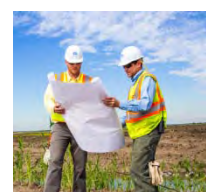
(overview, timeline, and issues related to trace heavy metals)

- Some of the key documents available at the EPA site include
  - Proposed Rule: Federal Register Notice (June 7, 2013)
  - Final Rule: Federal Register Notice (November 3, 2015)
  - Steam Electric Power Generating Point Source Category: Final Detailed Study Report (2009)
  - Standard Operating Procedures for analyses of FGD Wastewater
- Rulemaking documents can be found in the docket (Docket Number EPA-HQ-OW-2009-0819) at EPA's docket at [regulations.gov](http://regulations.gov)
- There are numerous documents related to ELG available from EPA at following EPA web site

<https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines-2015-final-rule>



- Primarily impacts coal-fired power plants with a generating capacity greater than 50 MW and integrated gasification combined cycle (IGCC) facilities
- Removes FGD wastewater, IGCC wastewater and coal combustion residuals (CCR) leachate from current definition of low volume waste
- Prohibits discharge of fly and bottom ash transport water and flue gas mercury control systems (FGMC) wastewaters
- Sets new numerical limits for arsenic, mercury, selenium, nitrite and nitrate for FGD wastewater from existing sources
- Sets new numerical limits for arsenic, mercury, selenium and TDS for IGCC wastewaters
- Sets new numerical limits for new CCR leachate sources
- Legacy wastewaters (generated prior to the effective date of a new permit) are not subject to the new rule limitations
- Implementation will begin with NPDES permit renewals on or after November 1, 2018 through December 2023





# ELG Rule Wastewater Streams Technologies/Discharge Limits – Overview

Waste Stream	Technology Basis and Numerical/Discharge Limits								
	Best Practical Technology (BPT)			Best Available Technology (BAT)			Best Available Demonstrated Control Technology (BADCT)		
		Daily Max	30 Day Avg						
Fly Ash Transport Water	TSS	100.0 mg/L	30.0 mg/L	Dry handling: Zero Discharge			Dry handling: Zero Discharge		
Bottom Ash Transport Water	TSS	100.0 mg/L	30.0 mg/L	Dry handling: Zero Discharge			Dry handling: Zero Discharge		
Flue Gas Desulfurization (FGD) Wastewater		Daily Max	30 Day Avg	Chemical precipitation+biological treatment			Evaporation:		
					Daily Max	30day Avg		Daily Max	30 Day Avg
	TSS	100.0 mg/L	30.0 mg/L	As	11 µg/L	8 µg/L	As	4 µg/L	-
				Hg	788 ng/L	356ng/L	Hg	39 ng/L	24 ng/L
	Oil & Grease	20.0 mg/L	15.0 mg/L	Se	23 µg/L	12 µg/L	Se	5 µg/L	-
				NO <sub>3</sub> /NO <sub>2</sub> as N	17.0 mg/L	4.4mg/L	TDS	50 mg/L	24 mg/L
Combustion Residual Leachate	Same as above for FGD Wastewater			Impoundment:			Chemical precipitation:		
					Daily Max	30 Day Avg		Daily Max	30 day Avg
	TSS	100.0 mg/L	30.0 mg/L	As	11 µg/L	8 µg/L	Hg	788 ng/L	356 ng/L
Flue Gas Mercury Control (FGMC) (flyash) Wastewater	Same as above for FGD Wastewater			Dry handling: Zero Discharge			Dry handling: Zero Discharge		
Gasification Wastewater	Same as above for FGD Wastewater			Evaporation:			Evaporation:		
					Daily Max	30 Day Avg		Daily Max	30 Day Avg
	As	4 µg/L		As	4 µg/L	-			
	Hg	1.8 ng/L	1.3 ng/L	Hg	1.8 ng/L	1.3 ng/L			
	Se	453 µg/L	227 µg/L	Se	453 µg/L	227 µg/L			
	TDS	38 mg/L	22 mg/L	TDS	38 mg/L	22 mg/L			

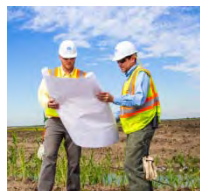
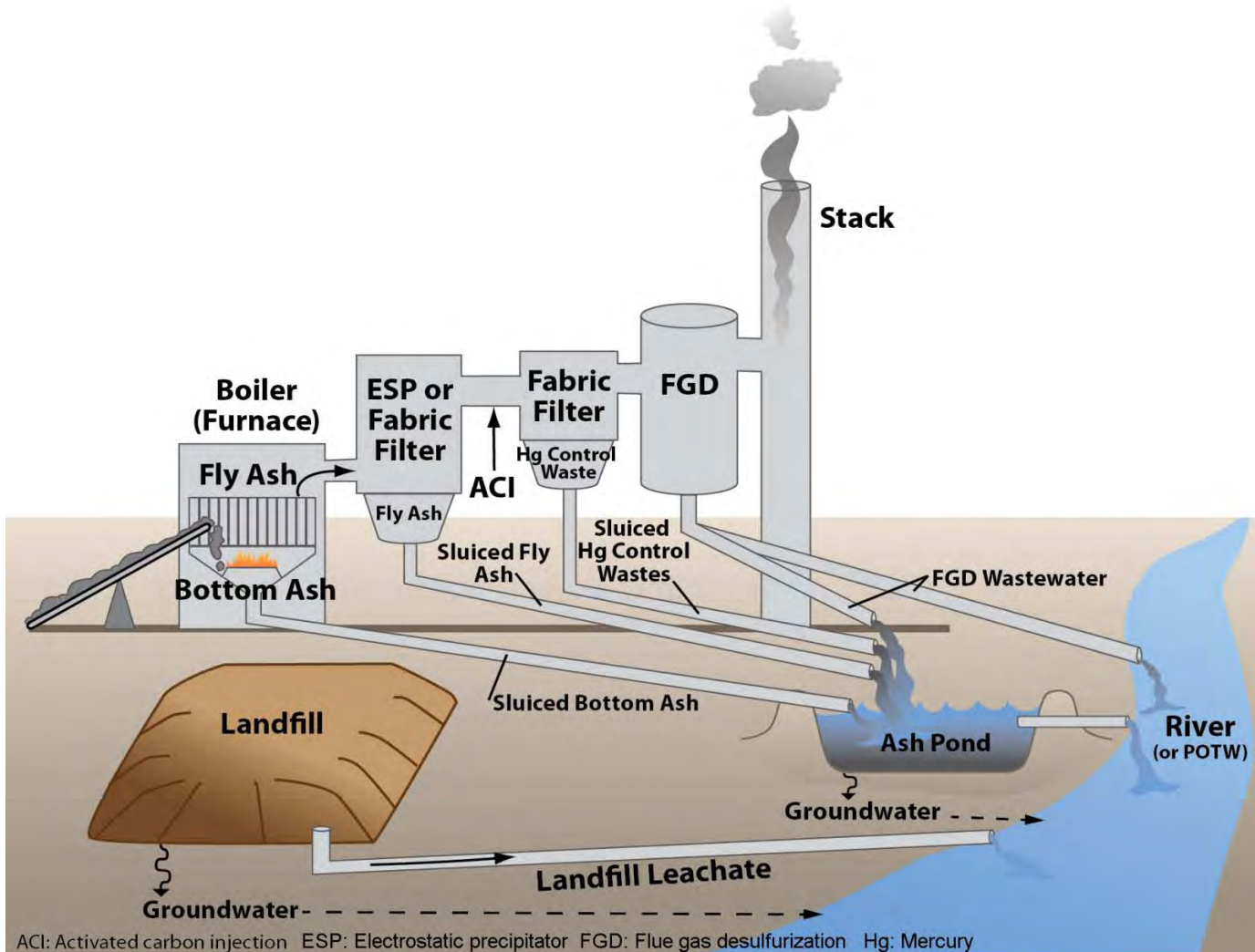
Source: EPA

- Permit Implementation Period (Nov. 2018 – Dec. 2023)  
Permitting authorities to incorporate final ELGs into NPDES and pre-treatment permits
- Deadline for ELG (Dec. 2023)  
Implementation if complying via voluntary incentive program for FGD Wastewater



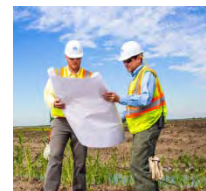
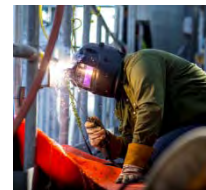


# ELG Examples of Trace Heavy Metal Removal and Fate in ELG Related Streams and Technologies Coal Fired Power Plant



Source EPA <https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines-2015-final-rule>

- Ash Transport Water
  - Dry bottom ash handling conversion
  - Dry fly ash handling conversion
  - Other technologies
- FGD Wastewater Treatment
  - Physical/chemical plus biological treatment
  - Zero liquid discharge (ZLD) technologies
  - Other technologies
- Combustion Residual Leachate Treatment
  - Physical/chemical treatment
  - Other technologies
- Flue Gas Mercury Control (flyash) Wastewater
  - Dry handling conversion
  - Zero liquid discharge (ZLD) technologies
  - Other technologies
- Other ELG Technologies





# Disposal of Coal Combustion Residuals (CCR)

(overview, timeline, and issues related to trace heavy metals)

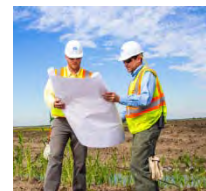
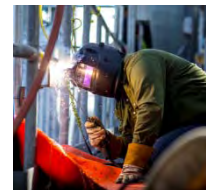
Some of the key documents available from the CCR include:

Final Rule: Federal Register Notice (Effective date October 19, 2015)

Docket Number: EPA-HQ-RCRA-2009-0640

The CCR Rule establishes technical requirements for CCR landfills and surface impoundments under Subtitle D of the Resource Conservation and Recovery Act (RCRA), the nation's primary law for regulating of solid waste

There are numerous documents related to the proposed update to the CCR from EPA: [www.epa.gov/coalash/coal-ash-rule](http://www.epa.gov/coalash/coal-ash-rule)



Upcoming October 17, 2016 deadline:

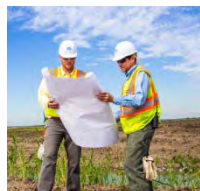
- Prepare Run-on/ Run-off Control for Landfills (257.81)
- Prepare Inflow Flood System Plan for Impoundments (257.82)
- Prepare Written Closure & Post-closure Plans (257.102-.104)
- Location Criteria (257.71)
- Complete Impoundment Hazard Potential Classification; Structural Stability Assessment; and Safety Factor Assessment (257.73)

Requirements	Demonstration by:
Location Restrictions	October 17, 2018
Design Criteria	October 17, 2016
Structural Integrity	October 17, 2016
Operating Criteria	January 18, 2016
Groundwater Monitoring	October 17, 2017



## Potential Impacts of Coal Combustion Residuals (CCR) Rule

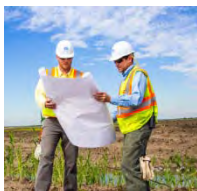
- Most Impoundments will Close
  - Safety/ Structural Standards
  - Corrective Action
  - Location Restrictions
  - Following ELG Rule implementation, through NPDES permits
- Dual State/ Federal Regulations
  - State-led enforcement of the Coal Ash Rule under RCRA
- Potential Rule Interpretations
- Potential Regulatory Uncertainty
  - Inactive sites (2017)



## Basic Statistics

- In 2012, over 470 coal fired facilities burned over 800 million tons of coal, generating approximately 110 million tons of CCR in 47 states and Puerto Rico
- CCR may be generated wet or dry
- CCR is sent off-site for disposal or beneficial use or disposed onsite in landfills and surface impoundments.
- In 2012, 40% of CCR was beneficially used with 60% disposed, mostly onsite
- There are over 310 active CCR landfills and 735 active CCR surface impoundments
- The average size of a CCR landfill is slightly over 120 acres, with an average depth of 40 feet; CCR surface impoundments average slightly over 50 acres with an average depth of 20 feet

Source: EPA



## Regulation of CCR under Subtitle D of Resource Conservation and Recovery Act (RCRA)

- Rule establishes national minimum criteria for the disposal of CCR in landfills and surface impoundments
- It provides a comprehensive regulatory program to address risks posed by:
  - Groundwater contamination
  - Structural failures of CCR surface impoundments; and
  - Fugitive dust emissions
- CCR units posing an unacceptable risk must retrofit or close
- Unacceptable risks are:
  - CCR surface impoundments failing to achieve or determine “factors of safety.” These units must close
  - Improper siting of CCR landfills or surface impoundments, which includes the inability to make the required engineering demonstrations. These units must close
  - Leaking unlined surface impoundments. These units must retrofit to a composite liner or close

Source: EPA





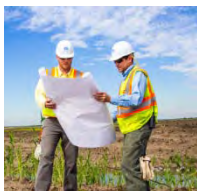
## CCR - Potential Affected Locations

- Currently, CCR generated in 47 states and Puerto Rico
- Approximately 40% of CCR beneficially reused
- Approximately 60% of CCR disposed:
  - 80% on-site
  - 20% off-site
- On-site disposal:
  - 310 active landfills (average size = 120 acres)
  - 735 active impoundments (average size = 50 acres)
- Proper management of CCR is a national/state level activity

Source (text): EPA

## Key Technical Provisions of the CCR Rule

- Applicability
- Definitions
- Location Restrictions
- Design Standards – Liners and Structural Integrity
- Operating Standards
  - Fugitive Dust Control
  - Run-on/Run-off for Landfills
  - Hydrologic and Hydraulic Capacity Requirements for Surface Impoundments
  - Inspections for Surface Impoundments and Landfills
- Groundwater Monitoring and Corrective Action
- Closure and Post-Closure Care
- Recordkeeping, Notifications and Internet Posting
- Beneficial Use





# CCR Background - Regulatory Requirements - Examples

Criteria	Impoundment	Landfill
Location Restrictions (§257.60 - §257.64)	•	•
Design Criteria (§257.71)	•	
Structural Integrity (§257.73)	•	
Air Criteria (§257.80)	•	•
Run-on and Run-off Controls (§257.81)		•
Hydrologic and Hydraulic Capacity (§257.82)	•	
Inspections (§257.83)	•	•
Groundwater Monitoring and Corrective Action (§257.90 - §257.98)	•	•
Closure and Post-Closure Care (§257.103 - §257.104)	•	•
Recordkeeping, Notification, and Internet Requirements (§257.105 - §257.107)	•	•

- Regulations are comprehensive with numerous provisions
- The timeframe for utilities to evaluate options and achieve compliance maybe short (e.g., 42 months) for operational site
- Compliance requirements for Inactive sites.
- Update in Coal Ash legislation

Source (table):  
 40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule)



## **Utilities currently undertaking background groundwater monitoring as per compliance for the CCR Rule**

New Groundwater Monitoring Requirements include:

- CCR surface impoundments, landfills and lateral expansions are required to install a groundwater monitoring system and conduct groundwater monitoring. This includes inactive surface impoundments and active facilities
- Compliance with requirements (up through detection monitoring and determination of background levels) within two years of effective date of the Rule
- Annual report certifying compliance, including data, to be posted on facility's website
- Groundwater requirements met throughout active life and closure/post closure period
- Facilities are currently obtaining the required 8 sampling events



## Upper Water Bearing Unit and Location of CCR Units (257.60)

CCR units at 5 feet above upper limit of uppermost aquifer or no hydraulic connection between the base of CCR unit and aquifer

## Groundwater Monitoring and Corrective Action (257.90-257.98)

- Evaluate Uppermost Aquifer and Location of CCR Units
  - Stratigraphy/lithology to define clay thickness and upper water bearing unit
  - Hydraulic conductivity
  - Historical potentiometric surface
  
- Assess Groundwater Quality
  - Groundwater Chemistry
  - Contaminants of interest (e.g., trace heavy metals, etc.)
  - Geochemical differences between surface impoundments and groundwater
  - Comparison of concentrations series and river levels and recharge; statistical evaluation



## Groundwater System Requirements

- Performance standard: sufficient number of wells, installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that accurately represent background quality and the groundwater passing the waste boundary
- Minimum of one up-gradient and three down gradient wells (adequate number to achieve an adequate background levels)
- May choose to install a multi-unit system  
Professional Engineer (PE) certifies system is equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system



- Specify sampling and analysis procedures and test methods
- Establish background levels
- Sample for background (e.g., minimum of eight)
- Statistical procedure to compare background to up-gradient concentrations
- Sample for assessment and detection monitoring consistent with statistical procedure chosen

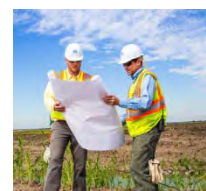
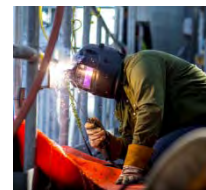


- Monitor semi-annually for Appendix III (release) parameters:
  - Boron
  - Calcium
  - Chloride
  - Fluoride
  - pH
  - Sulfate
  - TDS
- Determine if there has been a “statistically significant increase” (SSI) over background for each parameter
- Demonstrate SSI due to sampling and analysis (S&A) or other source error
- If SSI detected, establish Assessment Monitoring (e.g., within 90 days)



- Analyze for both Appendix III and Appendix IV parameters and constituents, resample within 90 days
  - Antimony
  - Arsenic
  - Barium
  - Beryllium
  - Cadmium
  - Chromium
  - Cobalt
  - Fluoride
  - Lead
  - Lithium
  - Mercury
  - Molybdenum
  - Selenium
  - Thallium
  - Radium 226 and 228 combined
  
- Establish groundwater protection standards (GWPSs) for each Appendix IV constituent
  
- GWPS is maximum contaminant levels (MCLs) or background, whichever is higher

- If any Appendix IV constituents are determined to have “statistically significant increase” (SSI) above the groundwater protection standards (GWPS):
  - Characterize the nature and extent of the release
  - Install additional monitoring wells
  - Within 90 days, initiate an assessment of corrective measures.
  
- Can demonstrate that contamination is attributable to other source or SSI is due to sampling and analysis error



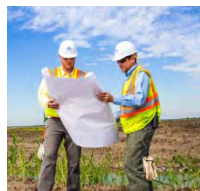


# CCR Examples of Trace Heavy Metals Containment and Fate in CCR Activities – Coal Fired Power Plant



# CCR Compliance & Engineering Activities - Requirements

- Assessment of sites to determine what other site features, require further action under the CCR Rule
- Evaluation of location restrictions & liner design on site structures in relation to §257.60 and §257.71
- Prepare required CCR reports at all units covered by the CCR Rule
- Evaluation of the groundwater monitoring system in place at the facilities & design a groundwater monitoring system that complies with the CCR Rule & protects the health, welfare & safety of people & the environment
- Appendix III and IV detection parameters for trace heavy metals
- Development of a comprehensive Sampling & Analysis Plan outlined in §257.93 of the new rule & train field sampling personnel in its implementation





- Design Development: Engineering and Design, Masterplanning, Stormwater, Closure/Post-Closure Plan, QA/QC Plan with Specifications, Operations Manual
- Ash Landfill Permitting for Construction & Operation including regulatory meetings, hearings & application(s)
- Ash Landfill Construction Management Services, Construction Certification Report
- Ash Landfill Closure Permitting, Notice of Intent for Closure, Post-Closure Care Plan & Final Closure Reporting, post-construction Stormwater Management Plan/NPDES
- Ongoing landfill facility permit modifications

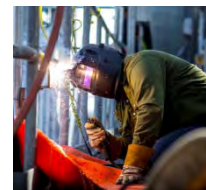


- Design landfill to receive fly & bottom ash including:
  - Geotechnical analyses
  - Bottom liner system
  - Surface water management system
  - Leachate collection & management system
  - Groundwater monitoring system
  - Final landform
  - Facility ancillary features
- Liner design includes composite liner & leachate collection systems
- Prepare application for State Department of Environmental Quality Solid Waste Permit

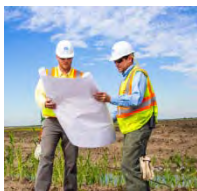


# Summary

- For coal fired power plants, the physical/chemical fate of trace heavy metals and other species can be predicted.
- Tools used to understand the fate of trace heavy metals (and other species) include the following: analytical chemical/physical techniques, mass & energy balances, engineering analysis of power plant equipment & technologies, modeling techniques (e.g. fuel combustion, hydrogeological, etc.), and other tools and methods.
- MATS compliance will reduce the stack gas emissions of mercury (Hg), filterable particulate matter (PM), hydrogen chloride (HCl), trace heavy metals, and other gaseous species.
- MATS compliance strategies can change levels of trace heavy metals in liquid and solid waste plant internal streams (e.g. potential transfer of trace heavy metals to internal liquid/solid streams).



- ELG compliance will reduce wastewater trace heavy metal (e.g. As, Hg, Se) and nitrate/nitrite discharges.
- In general, an impact of combined MATS/ELG compliance is to shift the fate (e.g., transfer, stabilization, etc.) of gaseous & liquid phase trace heavy metals and other species to the solid phase.
- CCR compliance will reduce trace heavy metal discharges and require mitigation for any off site discharge.
- Various air quality control (AQC), waste water treatment (WWT), and solid waste treatment (SWT) technologies are available to address MATS, ELG, and CCR compliance.





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