An Update of Effluent Limitation Guideline Treatment Options for Coal-Fired Power Plants

2018 Review Meeting for Crosscutting Technologies

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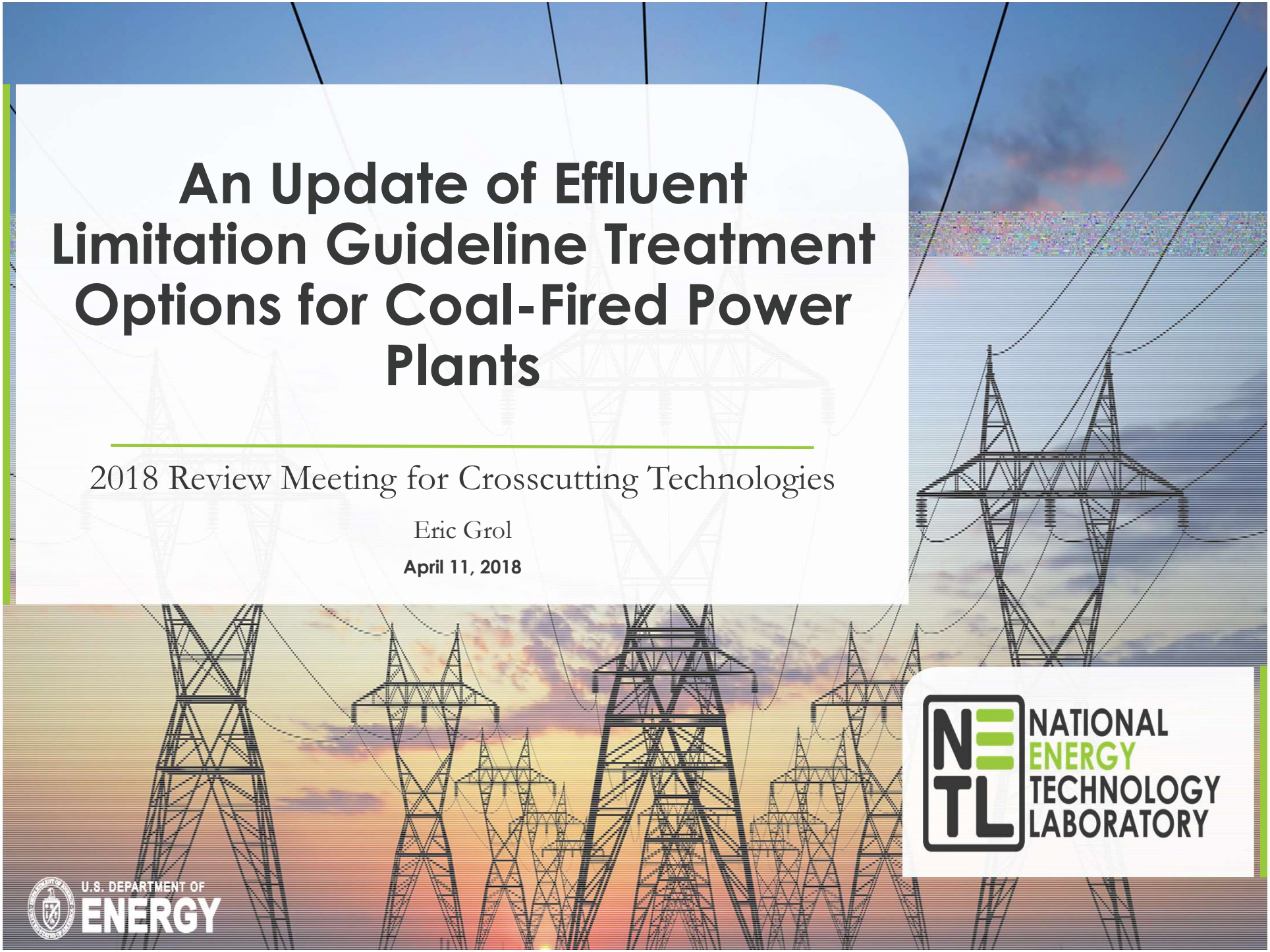
April 11, 2018



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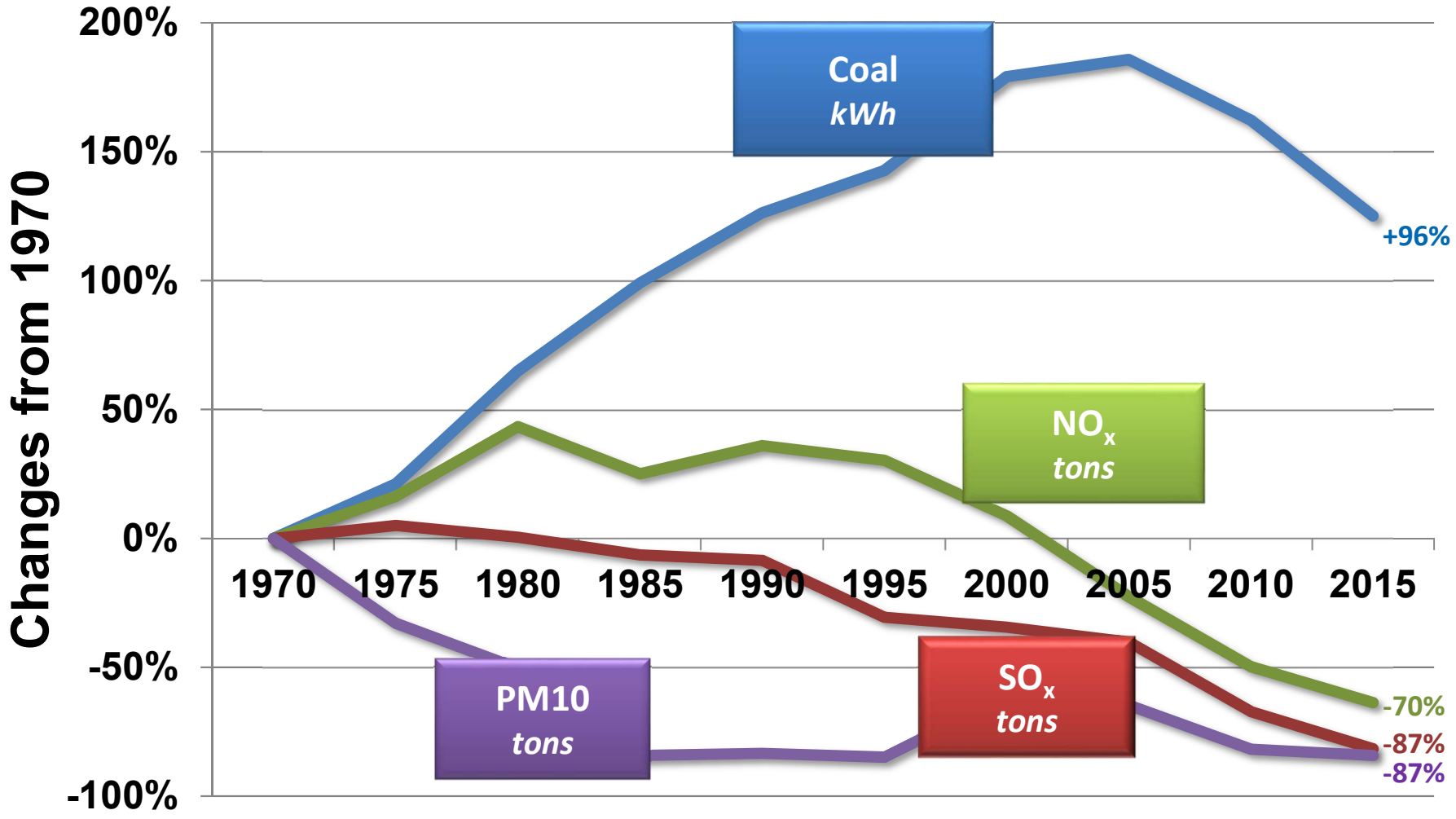
Overview

1. Coal regulatory overview
2. Existing sources ELG overview
3. Recent regulatory developments/technology needs
4. New sources ELG overview
5. Spray dryer evaporator for zero liquid discharge

Total Emissions from Coal-Fired Generation

Dramatic Reduction Despite Increase in Usage



Sources: EPA National Air Pollutant Emission Trends, EIA Annual Energy Review

Ozone (O_3)/PM | SO_x/NO_x | Cross State Air Pollution Rule (CSAPR) | Water

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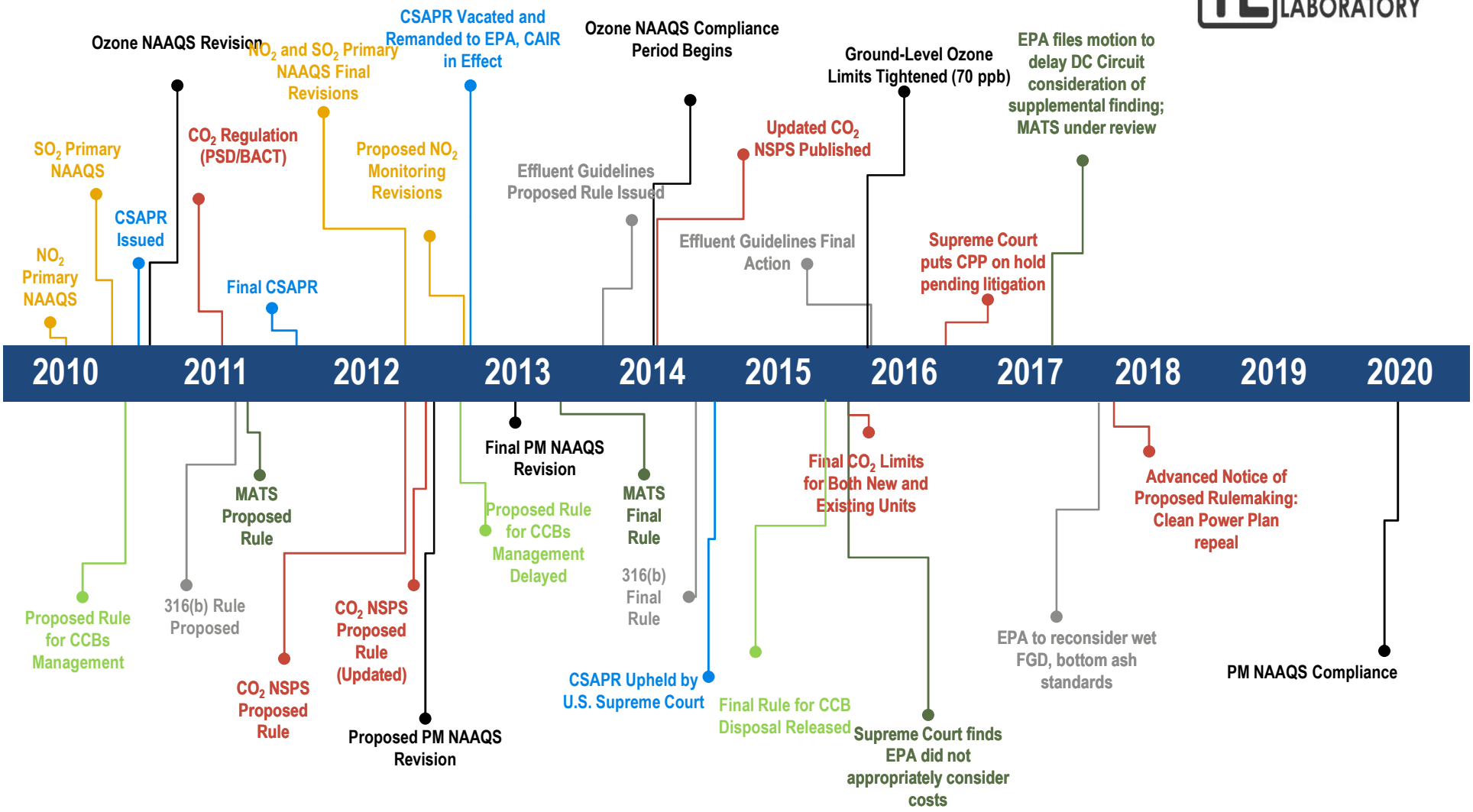
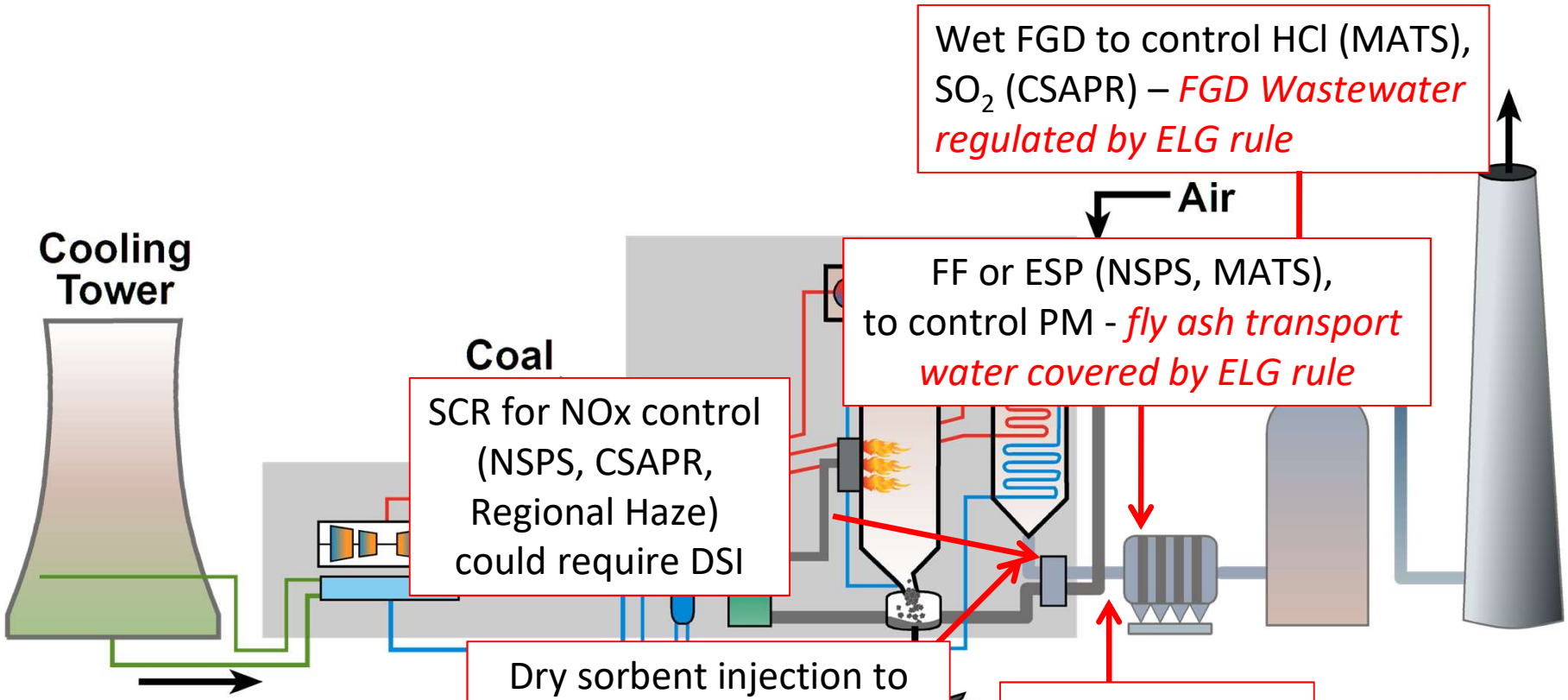


Coal Combustion Byproducts | MATS (Mercury/Air Toxics Standard) | CO_2

Pulverized Coal Power Plant

Air Quality Regulations: Water Impacts



New/Existing Source Standard Comparison

TABLE VIII–1—FINAL RULE: STEAM ELECTRIC MAIN REGULATORY OPTIONS

Wastestreams	Technology basis for the main BAT/NSPS/PSES/PSNS regulatory options					
	A	B	C	D	E	F
FGD Wastewater	Chemical Precipitation	Chemical Precipitation + Biological Treatment	Chemical Precipitation + Biological Treatment	Chemical Precipitation + Biological Treatment	Chemical Precipitation + Biological Treatment	Evaporation.
Fly Ash Transport Water	Dry handling	Dry handling	Dry handling	Dry handling	Dry handling	Dry handling.
Bottom Ash Transport Water.	Impoundment (Equal to BPT)	Impoundment (Equal to BPT)	Dry handling/ Closed loop (for units >400 MW); Impoundment (Equal to BPT)(for units ≤400 MW)	Dry handling/ Closed loop	Dry handling/ Closed loop	Dry handling/ Closed loop.
FGMC Wastewater	Dry handling	Dry handling	Dry handling	Dry handling	Dry handling	Dry handling.
Gasification Wastewater	Evaporation	Evaporation	Evaporation	Evaporation	Evaporation	Evaporation.
Combustion Residual Leachate.	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Impoundment (Equal to BPT).	Chemical Precipitation.	Chemical Precipitation.
Nonchemical Metal Cleaning Wastes.	[Reserved]	[Reserved]	[Reserved]	[Reserved]	[Reserved]	[Reserved].

Existing Source Standard

New Source Standard

Existing Sources (Direct & POTW)

- **FGD Wastewater: Chemical precipitation followed by biological treatment**
  - BAT is chemical precipitation systems that employs hydroxide precipitation, sulfide precipitation, and iron coprecipitation, followed by anoxic/anaeorbic fixed film biological treatment
- **Fly ash transport water: Dry handling**
  - BAT is dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo

Existing Sources (Direct & POTW)

- **Bottom ash transport water: Dry handling**
  - Water quench/mechanical drag conveyor (incline dewatering)
  - Recovered water reused in quench
- **Flue gas Hg control wastewater: Dry handling**
  - BAT is dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo (same as fly ash)

Existing Sources (Direct & POTW)

- **Combustion residual leachate**
  - Combustion residuals: wastes generated from combustion, generally collected by pollution control technologies, stored at the plant in landfills or surface impoundments. Leachate includes liquid, including suspended or dissolved solids, that has drained from landfill materials or that has passed through a containment structure (example: water leaking from an ash pond)
  - BAT: surface impoundments

Compliance timeline for existing sources

- **Specific deadline for compliance is at the discretion of the permitting authority, but should be as soon as possible beginning November 1, 2018, but no later than December 31, 2023**
- **Voluntary incentive option for FGD wastewater from existing sources**
  - Adopting the more stringent FGD wastewater standard based on evaporation (i.e., the new source FGD wastewater standard) allows more compliance time

ELG Rule Update

SUMMARY: Under the Clean Water Act ("CWA"), The Environmental Protection Agency (EPA) intends to conduct a rulemaking to potentially revise certain best available technology economically achievable ("BAT") effluent limitations and pretreatment standards for existing sources ("PSES") for the steam electric power generating point source category, which were published in the **Federal Register** on November 3, 2015. EPA is, accordingly, postponing the associated compliance dates in the 2015 Rule. In particular, EPA is postponing the earliest compliance dates for the new, more stringent, BAT effluent limitations and PSES for flue gas desulfurization ("FGD") wastewater and bottom ash transport water in the 2015 Rule for a period of two years. At this time, EPA

Technology Needs During Reconsideration

- **Regulatory reform agenda places a premium on existence of sufficient data on which to base regulations**

- **Utility Water Act Group (UWAG) comments in petition for reconsideration:**
  - Demonstration of biological treatment for plants burning subbituminous & lignite
  - Impact of FGD wastewater variability on compliance

Technology Needs: Assessing Biological Treatment for Subbit, Lignite Plants

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Comparison of 4-Day Average FGDW Treatment After Chemical Precipitation at Allen, Belews Creek, and Pleasant Prairie[99]

Analyte	Unit	4-Day Average Dissolved Effluent, Allen (E. Bituminous)	4-Day Average Dissolved Effluent, Belews Creek (E. Bituminous)	4-Day Average Dissolved Effluent, Pleasant Prairie (PRB)
Aluminum	(ug/l)	NQ[100]	ND	NQ
Arsenic*	(ug/l)	NQ	NQ	4.85
Boron	(ug/l)	58,600	150,000	9,930
Calcium	(ug/l)	1,750,000	3,490,000	639,000
Chloride	(mg/l)	3,300	7,780	1,950
Magnesium	(ug/l)	396,000	738,000	3,560,000
Manganese	(ug/l)	393	NQ	10,800
Mercury	(ng/l)	342	46,200	22.3
Nitrate/Nitrite	(mg/l)	13.3	19.8	160
Selenium	(ug/l)	91.1	1,210	2,080
Sodium	(ug/l)	31,300	48,900	518,000
Sulfate	(mg/l)	1,400	1,380	15,500
TDS	(mg/l)	7,560	20,100	22,400

*The pollutants highlighted are those for which EPA set new BAT limits.

- **Wide variability in FGD wastewater composition based on coal type**
- **UWAG: biological treatment cost, effectiveness depends on full pollutant "matrix"**

Technology Needs: Assessing Impact of FGD Wastewater Variability on Biological Treatment

- **Technology need during reconsideration: ability of biological treatment to demonstrate consistent performance with changing FGD wastewater quality**
- **Factors that impact FGD wastewater quality:**
  - Coal quality
  - FGD cycles of concentration that affect Cl, TDS
  - Cl, Mg levels in limestone reagent
  - Various forms of Se in FGD wastewater
  - Coal plant cycling
  - FGD wastewater temperature swings

Technology Needs: Determining Speciation of Heavy Metals in Coal Plant Wastewater

- "EPA intends to fully evaluate all of the issues raised in the petitions, including concerns about: cost and impacts to steam electric facilities, public availability of information on which the rule is based, lack of data for plants that burn certain types of coal, and validity of certain pollutant data used in EPA's 2015 Rule analysis."*
- Similar to Hg air emissions, need to characterize speciation of heavy metals in wastewater streams as functions of coal type, pollution controls
- Understanding coal plant early retirement drivers, and necessary lifespans for FGD wastewater treatment systems

* https://www.epa.gov/sites/production/files/2017-09/documents/steam-electric-elg_final_postpone-compliance-dates_fr-prepub_09-12-2017.pdf

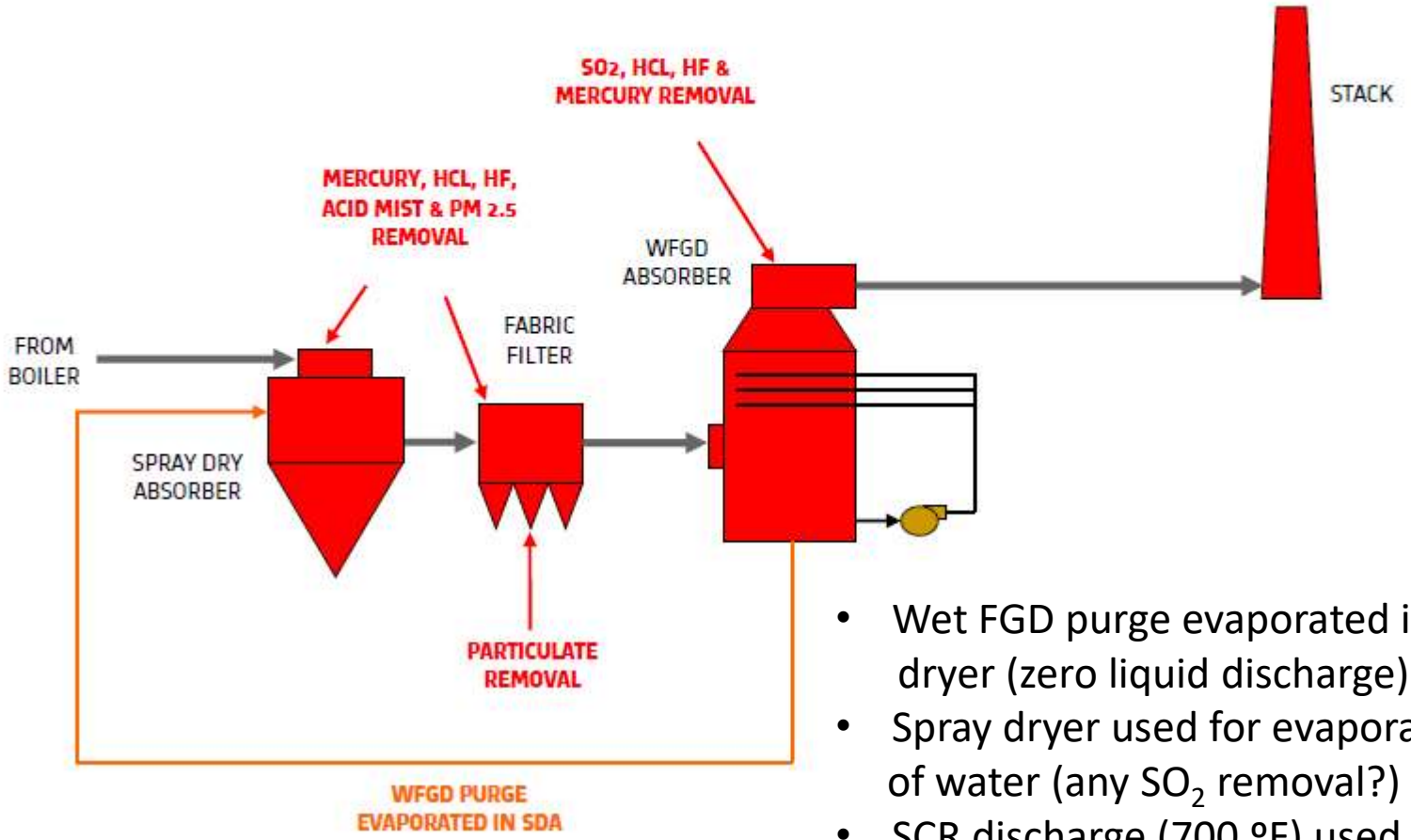
New Sources (Direct & POTW)

- **FGD Wastewater:**
  - BADCT/NSPS (Direct discharge): Limits on As, Hg, Se, TDS based on evaporation
  - Pretreatment Standards for New Sources (PSNS): Applies to units discharging to POTW, standard is limits on As, Hg, Se, TDS based on evaporation
- **Fly ash transport water: Dry handling**
  - Dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo
  - BADCT/NSPS for direct discharge units, PSNS for units that discharge to POTW

New Sources (Direct & POTW)

- **Bottom ash transport water: Dry handling – BADCT/NSPS (direct discharge) and PSNS (POTW discharge)**
  - Water quench/mechanical drag conveyor (incline dewatering)
  - Recovered water reused in quench
- **Flue gas Hg control wastewater: Dry handling – BADCT/NSPS (direct discharge) and PSNS (POTW discharge)**
  - Dry vacuum system using mechanical exhauster to pneumatically convey fly ash from hoppers to a silo (same as fly ash)

Cliffside - Integrated AQCS



- Wet FGD purge evaporated in spray dryer (zero liquid discharge)
- Spray dryer used for evaporation of water (any SO_2 removal?)
- SCR discharge (700 ºF) used as heat source for evaporation

Spray Dryer Evaporator – FGD Wastewater ZLD

- **Controlling chloride levels in wet FGD blowdown a driving force in spray dryer evaporator design**
  - Wet FGD & spray dryer materials of construction

- **Evaporation heat source is flue gas "robbed" from air preheater in boiler; spray dryer evaporation degrades plant heat rate**
  - 900 MW low-Cl PRB unit ≈ 30 – 50 gpm blowdown, 2-3% flue gas bypass[1]
  - 900 MW eastern coal unit ≈ 170 – 200 gpm blowdown, 10-12% flue gas bypass[1]

- **Baghouse will see 5 – 10% increase in solids loading**

1. "*Salt Dryers for TRUE Zero Liquid Discharge from WFGD Wastewater*," S. Feeney and M. Klidas, POWER Engineering, June 20, 2016

Acknowledgements

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