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THE CLEAN AIR ACT AMENDMENTS OF 1990: HAZARDOUS AIR POLLUTANT REQUIREMENTS AND THE DOE CLEAN COAL TECHNOLOGY PROGRAM

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I. INTRODUCTION

The purpose of the U. S. Department of Energy - Office of Fossil Energy (DOE FE) Clean Coal Technology Program (CCTP) is to provide the U. S. energy marketplace with advanced, efficient, and environmentally sound coal-based technologies[1]. The design, construction, and operation of Clean Coal Technology Demonstration Projects (CCTDP) will generate data needed to make informed, confident decisions on the commercial readiness of these technologies. These data also will provide information needed to ensure a proactive response by DOE and its industrial partners to the establishment of new regulations or a reactive response to existing regulations promulgated by the U. S. Environmental Protection Agency (EPA). The objectives of this paper are to: (1) Present a preliminary examination of the potential implications of the Clean Air Act Amendments (CAAA) - Title III Hazardous Air Pollutant requirements to the commercialization of CCTDP; and (2) help define options available to DOE and its industrial partners to respond to this newly enacted Legislation.

II. CAAA REQUIREMENTS

Figure 1 summarizes the issues and strategy to be followed by the EPA to develop CAAA Title III Hazardous Air Pollutant emission standards for routine releases from stationary sources. More specifically, Title III lists 189 Hazardous Air Pollutants and directs EPA to promulgate Maximum Achievable Control Technology (MACT) standards for industrial sources emitting these contaminants. MACT standards may be achieved through process changes, installation of pollution controls, materials substitution, or operator training and certification. The failure, of these controls, to provide an ample margin of safety to public health, e.g., a residual cancer risk exceeding one in 10,000 to the most exposed person, would require the EPA Administrator to develop more stringent emission limits.

Sources which may be regulated include "electric utility steam generating units" and "major sources." Section 301((a)sub.8) defines an electric utility steam generating unit as "... any fossil fuel fired combustion unit of more than 25 megawatts (MW_e) that serves a generator that produces electricity for sale..." A "major source" is any stationary source or group of stationary sources located within a contiguous area and can emit more than 10 tons per year (tpy) of any one listed pollutant and/or 25 tpy for any combination of listed pollutants.

Figure 2 presents the operational schedule for the CCTP and the statutory schedule for the Title III requirements. As shown, there is potential overlap in the schedules among these two programs. Thus, there is a unique opportunity for the CCTP and its industrial partners to act proactively and collect data from commercial-scale fossil-based operations in time to contribute to the EPA rule-making process. These data can ensure the development of appropriate and defensible regulations for fossil-based technologies. That is, control of pollutants emitted in sufficient quantities that endanger public health. Development of regulations, to the extent needed, should be based on comprehensive sets of measurements, from representative technology and processing options. Such measurements from fossil-based technologies do not exist today for most Title III contaminants. Without measurement data, engineering estimates can be prepared to guide monitoring and control efforts. But these estimates should not be used as the basis for regulations because of the large variations that exist in fuel feedstock quality, combustion chemistry, and efficiency of existing pollution control systems. In this light, the following sections attempt to prioritize these needs.

III HAZARDOUS AIR POLLUTANT EMISSIONS FROM COAL-BASED SYSTEMS

The air pollutants that may be emitted from coal-based technologies include, but are not limited to the following: Priority pollutants (e.g., SO_2, NO_x); low molecular weight hydrocarbons (e.g., CH_4, etc.); and, trace emissions of metallic constituents (e.g. As, Se, Hg, Cd, Pb), polycyclic organics (e.g., benzo-a-pyrene), and fine particulate matter (0.1-0.6 um).

Many trace elements are contained in coal (Table 1). Although their concentrations are low, the total potential mass of gaseous emissions from a coal-fired power plant may be relatively high because of the total amount of coal burnt during a year. We calculate that a 400 MW_e coal-fired power plant will burn about 3500 tons per day (tpd) of coal. At this rate, trace elements in the coal at concentrations higher than 40 parts per million (ppm) and with 25% volatility have the potential to be in the effluent stream in quantities exceeding 10 tpy - the Title III threshold. Figure 3 graphically displays the relationship between volatility, concentration, and stack emissions for a plant burning 3445 tpd of coal. Estimates calculated from Figure 3 are based on the assumption that all the trace elements in the gas-phase will be entrained within the stack gas. In reality, a fraction of these elements will condense on, or be adsorbed by ash particles that will be removed by particulate pollution control equipment (e.g. electrostatic precipitators.) However, further analysis seems warranted because some elements are preferably retained on very fine particles that can escape through the control equipment, some fraction also will be exhausted with the hot flue gases.

The composition of hydrocarbons in the effluent streams depends on several process and combustion conditions (e.g. temperature, pressure, steam/coal ratio, hydrogen/coal ratio, and residence times.) Similarly, variations in coal type and reactivity will result in different gas emissions. Residence time affects the amount of carbon conversion and sulfur retention in the ash, and consequently the composition of the effluent stream. Thus residence time is one factor that can be used to aggregate different types of coal-gasification and fluidized bed technologies into different pollutant emission classes. An entrained-bed gasifier, for example, has low residence times (usually less than 1 s.); whereas fluidized-bed gasifiers have much longer residence times (usually 3 to 7 min.). Finally, the amount of water that enters a gasifier can affect the composition of the effluent stream. For example, in a coal gasifier water comes from three sources: steam injection, coal moisture and feed of water slurry. In general, higher steam concentrations result in higher hydrogen concentrations within the effluent gas.

Due to the paucity of measurement data of Title III-type emissions from coal-based facilities, we have attempted to identify the types of Title III compounds likely to be emitted. These characterizations are based on the fundamental assumption that the quantity and type of stack emissions will be a function of trace element concentration in the feedstock coal, and process and combustion chemistry.

Trace elements, if present in the feedstock coal, are sufficiently volatile that they would likely be present in all complete combustion systems. These elements include compounds of antimony, arsenic, beryllium, cadmium, chlorine, lead, mercury, selected radionuclides, and selenium. The chemical species present in the gaseous waste streams are likely to be different in oxidizing and reducing environments. In oxidizing environments, the metals would be mostly oxides, although some chlorides also would be present. In reducing environments, the metals would be mostly chlorides, hydrates and sulfides. As shown in Table 1, the trace elements with the highest potential concentrations are: arsenic, cadmium, chromium, lead, and selenium. In addition, some combustion by-products (e.g. polycyclic organic matter including primarily benzo-a-pyrene) are so highly refractory that they too could be present in complete combustion emission streams.

Although CCTDP generally have very low emission rates, certain Title III chemicals still require further investigation. For example, the following chemicals could form in reduced conditions and survive partial combustion: bis(2-ethylexyl)phthalate (DEHP), carbonyl sulfide, di-methyl sulfate, dibenzofurans, formaldehyde, hydrogen chloride, hydrogen fluoride, methyl chloride, pentachlorophenol, phenol, tetracloroethylene, trichloroethane, 2,4,5 trichlorphenol. Similarly under highly reducing conditions the following substance also may be emitted: aniline, benzene, biphenyl, carbon disulfide, carbon tetrachloride, chlorobenzene, ethylbenzene, methanol, napthalene, ortho-, meta-, and para-cresols, quinoline, toluene, xylenes. Trichlorethylene and nickel compounds (from some oils) also may be present in the gaseous waste streams from processes involving co-processing coal with other hydrocarbons. In Table 2, compounds unlikely to be formed or emitted from coal-fired facilities are listed.

IV. SUGGESTED INITIATIVES

The potential impacts that Title III regulations could have on projects supported by the CCTP are not known at this early date. Given the lack of data on the type and quantity of air pollutants emitted by coal-fired facilities, the time lag in collecting such data, and the intricacies of the EPA rule-making process, a proactive response by DOE and its industrial partners to the CAAA seems warranted. Among the range of options available to DOE and its industrial partners are the following: Begin to develop independent critical estimates of the risks to health presented by hazardous air pollutants emitted by coal-based facilities; begin to examine critically the technical and economic efficiency of various pollution control strategies for Title III pollutants; sample existing coal-fired facilities for Title III contaminants; and sample newly emerging clean-coal processing options for Title III contaminants.

Of these options, serious, but significantly different risks are assumed. The first two options reduce the short-term financial and contractual risks to the CCTP and the private sector, by simply letting the technological and regulatory processes move forward without collecting new data. The long-term risk to the commercial viability of clean-coal presented by these options, however, are large. The EPA Administrator could determine that fossil-fuel fired technologies need to be regulated through the application of controls that could be costly or not readily available. The other two options reduce the long-term risk, by collecting technology-specific data, but increase short-term administrative and financial costs.

DOE and its industrial partners have both a vested interest and opportunity to ensure the development of appropriate regulations for fossil-based technologies. Clearly, the foundation for this is the establishment of a measurements database. If sampling and analysis efforts begin, several important programmatic decisions must be made to increase the efficiency of the data collection and decrease the overall costs of these efforts. In addition, independent evaluations of health risks, and pollutant control technologies are needed.

A. Analytical Protocols

There are no routine sampling and analytical protocols for many compounds listed in Title III. Table 3 cross-references analytical protocols identified by EPA[2] and the National Institute for Occupational Safety and Health - NIOSH[3] with the air pollutants identified by the CAAA. Only 31 of the 189 compounds listed, have protocols identified by the EPA. NIOSH has developed protocols for 111 of the listed air toxics; however, these suggested protocols were developed solely for understanding threshold limits for worker exposure levels. Furthermore, because of the difference in the environments, i.e., "hot" stack gases as opposed to inhalable air, these protocols may be inappropriate. They may, however, be used to develop a comprehensive, uniform set of protocols that all contractors could follow when conducting chemical sampling and analysis.

B. Indicator Chemicals

In the collection of the supplemental monitoring data, contaminants that should be studied in greater detail must be identified. In this context, a formal definition for the term "considerable concern" is needed. In simple terms, the trigger for considerable concern can be based on concentration, mass, or risk. Triggers based on the first strategy can be as simple as a measured concentration in the stack that is equal to or greater than the Occupational Safety and Health Administration Permissible Exposure Level (OSHA PEL). The second trigger could be defined as Title III chemicals likely to be emitted in quantities greater than 10 tpy. Finally, the third trigger could be chemicals producing estimated lifetime cancer risks (or equivalent for noncarcinogens) exceeding one in 100,000 to maximally exposed individuals. The first approach may be sufficient for purposes of screening, the second for detailed sampling, and the third might be used for input into the EPA rule-making process, including the evaluation of the effectiveness of different control strategies. These triggers should be identified early in any program so that monitoring schedules can be quickly adjusted to eliminate unnecessary tests and implement more useful ones.

C. Quality Assurance/Quality Control

To ensure the credibility of all data collected, it will be important to integrate a quality assurance/quality control program with the sampling and analysis program. The appropriate methods should be clearly defined in the early stages of any monitoring effort.

D. Evaluation of Health Risks

Preliminary estimates from coal-conversion facilities suggest that these operations might emit hazardous air pollutants in excess of the 10 or 25 tpy guidelines. Given the strong possibility that EPA will regulate these sources, efforts are needed to develop independent, realistic estimates of the health hazards from these releases. These estimates could be presented to EPA rule-makers as they evaluate the need to control emissions from coal-based facilities.

E. Pollutant Control Technologies

Independent efforts should begin to evaluate the technical and economic efficiency of different control strategies. Initial efforts should focus on the trace element. With the collection of more data, the program can be refined to include analyses of other Title III materials.

V. CONCLUSION

At present only limited data exist to characterize the types and quantities of Title III that could be emitted to the atmosphere from fossil-based technologies. The operation of CCTDP provides an opportunity to collect and sample data from a wide range of new coal-based technologies. Collection of these data will ensure the development of appropriate regulations, without a bias resulting from a lack of data, for fossil based technologies. This will help ensure equitable treatment for all clean coal projects regarding any future Title III regulations promulgated by EPA-rule makers. In this context, DOE is now evaluating its options to contribute to this process.

VI. REFERENCES

1. U. S. Department of Energy, 1991. Clean Coal Technology Demonstration Program, DOE/FE-021p Washington DC.

2. U. S. Environmental Protection Agency, 1977. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Stationary Source Methods, EPA-600/4-77-027b, Research Triangle Park, NC.

3. U. S. Department of Health and Human Services, 1988. NIOSH Manual of Analytical methods - Volume 7, Washington, DC.

Table 1. Base Case Estimate of Potential Trace Elements Discharged to Atmosphere without Scrubber* (from EPA, 1980).

Incl. in Title III	Element	Emission > 10 ton/yr	ppm in Coal (Dry Basin)	Average % Emitted	Emitted kg/d	Maximum ton/yr
Yes	Antimony		0.5	25	0.40	
Yes	Arsenic	x	8 - 45	25	11 - 36	13
Yes	Beryllium		0.6 - 7.6	25	0.5 - 6	2.2
No	Boron		13 - 198	25	10 - 160	
No	Bromine		14.2	100	46	
Yes	Cadmium		0.14	35	0.16	
Yes	Chlorine	x	400 - 1000	100	1300 - 3250	1170
No	Fluorine		50 - 167	100	160 - 550	
Yes	Lead	x	8 - 14	35	9 - 16	5.7
Yes	Mercury		0.04 - 0.49	90	0.1 - 1.4	0.5
No	Molybdenum		0.6 - 8.5	25	0.5 - 7	
Yes	Selenium		2.2	70	5.0	1.8
No	Vanadium		8.7 - 67	30	8.5 - 65	
No	Zinc		0 - 53	25	0 - 43	
				Total	1547 - 4186	

*Based on a feed rate of 3445 tpd of Illinois No. 6 coal.

Table 2. Title III Pollutants Which Are *Unlikely* to Exist in Effluents from CCTDP.

Bromoform	Methyl methacrylate
Calcium cyanamide	4,4-Methylene bis(2-chloroaniline)
Captan	Methylene diphenyl diisocyanate (MDI)
Carbaryl	4,4-Methylenedianiline
Chloramben	N-Nitrosomorpholine
Chlordane	Parathion
Chloroacetic acid	Pentachloronitrobenzene (Quintobenzene)
Chloroform	Phosgene
Diazomethane	Phosphine
Dichloroethyl ether (Bis(2-chloroethyl)ether)	Propionaldehyde
1,3-Dichloropropene	Styrene oxide
Diethanolamine	1,1,2,2-Tetrachloroethane
Dimethyl carbamoyl chloride	Titanium tetrachloride
Dimethyl formamide	Toxaphene (chlorinated camphene)
1,1-Dimethyl hydrazine	1,1,2-Trichloroethane
Hexachlorocyclopentadiene	Vinyl acetate
Hexachloroethane	Vinyl bromide
Hexamethylphosphoramide	Vinylidene chloride (1,1-Dichloroethylene)
Hydrazine	

Table 3: A Cross-Referencing of Hazardous Air Pollutants Listed in the CAAA with Analytical Protocols Identified by the U.S. Environmental Protection Agency and the National Institute for Occupational Safety and Health.

CAS NO.	TOXICS	NIOSH ANALYTICAL METHOD	E. P. A. METHOD CLASS	E. P. A. REFERENCES
75070	ACETALDEHYDE	-0-	-	-0-
60355	ACETAMIDE	-0-	-	-0-
79061	ACYLAMIDE	-0-	-	-0-
75058	ACETONITRILE	S165	-	-0-
98862	ACTOPHENONE	-0-	-	-0-
53963	2-ACETYLAMINOFLUORENE	-0-	-	-0-
107028	ACROLEIN	118,211	-	-0-
79107	ACRYLIC ACID	-0-	-	-0-
107131	ACRYLONITRILE	202,S156	-	-0-
107051	ALLYL CHLORIDE	S111	-	-0-
92671	4-AMINOBIPHENYL	269	-	-0-
62533	ANILINE	168,S163	-	-0-
90040	O-ANISDINE	-0-	-	-0-
1332214	ASBESTOS	239,245,309	-	-0-
71432	BENZENE (INCLUDING BENZENE FROM GASOLINE)	127,S311,1008	T	12
92875	BENZIDINE	243,315	-	-0-
98077	BENZOTRICHLORIDE	-0-	-	-0-
100447	BENZYL CHORIDE	S115	-	-0-
92524	BIPHENYL	S24	-	-0-
117817	BIS(2-ETHYLHEXYL)PHTHALATE (DEHP)	-0-	-	-0-
542881	BIS(CHLOROMETHYL)ETHER	333	-	-0-
75252	BROMOFORM	S114,1003	O	11
106990	1,3-BUTADIENE	S91	D	3
156627	CADMIUM CYANAMIDE	-0-	-	-0-
105602	CAPROLACTAM	-0-	-	-0-
133062	CAPTAN	-0-	-	-0-
63252	CARBARYL	S273	-	-0-
75150	CARBON DISULFIDE	179,S248	-	-0-
56235	CARBON TERACHLORIDE	127,S314	T	15
463581	CARBONYL SULFIDE	-0-	-	-0-
120809	CATECHOL	-0-	-	-0-
133904	CHLORAMBEN	-0-	-	-0-
57749	CHLORDANE	115	-	-0-
7782505	CHLORINE	209	-	-0-
79118	CHLOROACETIC ACID	-0-	-	-0-
532274	2-CHLOROACETOPHENONE	291	-	-0-
108907	CHLOROBENZENE	133,1003	O	11
510156	CHLOROBENZILATE	-0-	-	-0-
67663	CHLOROFORM	127,S351	T	15
107302	CHLOROMETHYL METHYL ETHER	220	-	-0-
126998	CHLOROPRENE	S112	-	-0-
1319773	CRESOLS/CRESYLIC ACID (ISOMERS AND MIXTURE)	S167 R	-	-0-

95487	O-CRESOL	S167	-	-0-
108394	M-CRESOL	S167	-	-0-
106445	P-CRESOL	S167	-	-0-
98828	CUMENE	S23,1501	O	6
94757	2,4,-D,SALTS AND ESTERS	S279	-	-0-
3547044	DDE	-0-	-	-0-
334883	DIAZOMETHANE	S137	-	-0-
132649	DIBENZOFURANS	-0-	-	-0-
96128	1,2-DIBROMO-3-CHLOROPROPANE	-0-	O	22
84742	DIBUTYLPHTHALATE	S33	-	-0-
106467	1,4-DICHLOROBENZENE(P)	S281	-	-0-
91941	3,3-DICHLOROBENZIDENE	246	-	-0-
111444	DICHLOROETHYL ETHER (BIS(2-CHLORETHYL)ETHER)	S357 H	-	-0-
542756	DICHLOROPROPEN	-0-	-	-0-
62737	DICHLORVOS	295	-	-0-
111422	DIETHANOLAMINE	221,S139	-	-0-
121697	N,N-DIETHYL ANILINE (N,N-DIMETHYLANILINE)	-0-	-	-0-
64675	DIETHYL SULPHATE	-0-	-	-0-
119904	3,3-DIMETHOXYBENZIDINE	-0-	-	-0-
60117	DIMETHYL AMINOAZOBENZENE	-0-	-	-0-
119937	3,3-DIMETHYL BENZIDINE	-0-	-	-0-
79447	DIMETHYL CARBAMOYL CHLORIDE	-0-	-	-0-
68122	DIMETHYL FORMAMIDE	S255	-	-0-
57147	1,1-DIMETHYL HYDRAZINE	248,S143	-	-0-
131113	DIMETHYL PHTHALATE	-0-	-	-0-
77781	DIMETHYL SULFATE	-0-	-	-0-
534521	4,6-DINITRO-O-CRESOL, AND SALTS	S166	-	-0-
51285	2,4-DINITROPHENOL	-0-	-	-0-
121142	2,4,-DINITROTOLUENE	S215	-	-0-
123911	1,4-DIOXANE (1,4-DIETHYLENEOXIDE)	S215	-	-0-
122667	1,2-DIPHENYLHYDRAZINE	-0-	-	-0-
106898	EPICHLOROHYDRIN (1-CHLORO-2,3-EPOXPROPANE)	-0-	-	-0-
106887	1,2-EPOXYBUTANE	-0-	-	-0-
140885	ETHYL ACRYLATE	S105,2519	-	-0-
100414	ETHYL BENZENE	1501	O	6
51796	ETHYL CARBAMATE (URETHANE)	-0-	-	-0-
75003	ETHYL CHLORIDE (CHLOROETHANE)	2519	O	20
106934	ETHYLENE DIBROMIDE (DIBROMOETHANE)	1008	O	12
107062	ETHYLENE DICHLORIDE (1,2 DICHLOROETHANE)	S118	T	13
107211	ETHYLENE GLYCOL	338	-	-0-
151564	ETHYLENE OXIDE	286,1607	O	9
96457	ETHYLENE THIOUREA	281	-	-0-
75343	ETHYLIDENE DICHLORIDE (1,1-DICHLOROETHANE)	-0-	-	-0-
50000	FORMALDEHYDE	125,235,318,S327 ,354	-	-0-
76448	HEPTACHLOR	287	-	-0-

118741	HEXACHLOROBENZENE	-0-	-	-0-
87683	HEXACHLOROBUTADIENE	307	-	-0-
77474	HEXACHLOROCYCLOPENTADIENE	308,2[illegible]18	O	4
67721	HEXACHLOROETHANE	S101	-	-0-
822060	HEXAMETHYLENE-1,6-DIISOCYANATE	-0-	-	-0-
680319	HEXAMETHYLPHOSPHORAMIDE	-0-	-	-0-
110543	HEXANE	S90,1500	O	2
302012	HYDRAZINE	248,S237	-	-0-
7647010	HYDROCHLORIC ACID	-0-	-	-0-
7664393	HYDROGEN FLUORIDE (HYDROFLUORIC ACID)	117,262,S176	-	-0-
123319	HYDROQUINONE	S57	-	-0-
78591	ISOPHORONE	S367	-	-0-
58899	LINDANE (ALL ISOMERS)	S290	-	-0-
108316	MALEIC ANHYDRIDE	302	-	-0-
67561	METHANOL	247,559,2000	O	1
72435	METHOXYCHLOR	S371	-	-0-
74839	METHYL BROMIDE (BROMOMETHANE)	S372,2520	O	16
74873	METHYL CHLORIDE (CHLOROMETHANE)	201,S99	O	17
71556	METHYL CHLOROFORM (1,1,1-TRICHLOROETHANE)	127,S328	T	13
78933	METHYL ETHYL KETONE (2-BUTANONE)	127,S3,2500	O	8
60344	METHYL HYDRAZINE	-0-	-	-0-
74884	METHYL IODIDE (IODOMETHANE)	S98	-	-0-
108101	MEHTYL ISOBUTYL KETONE (HEXONE)	S18,1300	O	7
624839	METHYL ISCOYANATE	-0-	-	-0-
624839	METHYL METHACRYLATE	S43	-	-0-
80626	METHYLMETHACRYLATE	-0-	-	-0-
1634044	METHYL TERT BUTYL ETHER	-0-	-	-0-
101144	4,4-METHYLENE BIS(2-CHLOROANILINE)	236,342	-	-0-
75092	METHYLENE CHLORIDE (DICHLOROMETHANE)	121,S329	T	18
101688	METHYLENE DIPHENYL DIISOCYANATE (MDI)	-0-	-	-0-
101779	4,4'-METHYLENEDIANILINE	-0-	-	-0-
91203	NAPHTHALENE	264	-	-0-
98953	NITROBENZENE	S217	-	-0-
92933	4-NITROBIPHENYL	213	-	-0-
100027	4-NITROPHENOL	-0-	-	-0-
79469	2-NITROPROPANE	272	-	-0-
684935	N-NITROSO-N-METHYLUREA	-0-	-	-0-
62759	N-NITROSODIMETHYLAMINE	252,299	-	-0-
59892	N-NITROSOMORPHOLINE	-0-	-	-0-
56382	PARATHION	244,253,329,S120 ,S121	-	-0-
82688	PENTACHLORONITROBENZENE (QUINTOBENZENE)	-0-	-	-0-
87865	PENTACHLOROPHENOL	230,S29722	-	-0-

108952	PHENOL	330,S330	-	-0-
106503	P-PHENYLENEDIAMINE	-0-	-	-0-
75445	PHOSGENE	219	-	-0-
7803512	PHOSPHINE	S332	-	-0-
7723140	PHOSPHORUS	242,257,351,S334	-	-0-
85449	PHTHALIC ANHYDRIDE	S179	-	-0-
1336363	POLYCHLORINATED BIPHENYLS (AROCLORS)	244,253,329,200	-	-0-
1220714	1,3-PROPANE SULTONE	-0-	-	-0-
57578	BETA-PROPIOLACTONE	-0-	-	-0-
123386	PROPIONALDEHYDE	-0-	-	-0-
114261	PROPOXUR (BAYGON)	-0-	-	-0-
78875	PROPYLENE DICHLORIDE (1,2-DICHLOROPROPANE)	S95,1013	O	14
75569	PROPYLENE OXIDE	S75,1612	O	10
75558	1,2-PROPYLENIMINE 92-METHYL AZIRIDINE)	-0-	-	-0-
91225	QUINOLINE	-0-	-	-0-
106514	QUINONE	S181	-	-0-
100425	STYRENE	121,S30,150[illegible]	O	6
96093	STYRENE OXIDE	303	-	-0-
1746016	2,3,7,8-TETRACHLORODIBENZO-P-D IOXIN	-0-	-	-0-
79345	1,1,2,2-TETRACHLOROETHANE	S124	-	-0-
127184	TETRACHLOROETHYLENE (PERCHLOROETHYLENE)	127,S335	T	13
7550450	TITANIUM TETRACHLORIDE	-0-	-	-0-
108883	TOLUENE	127,S343,1500,15 01	O	2,6
95807	2,4-TOLUENE DIAMINE	-0-	-	-0-
584849	2,4-TOLUENE DIISOCYANATE	141,168	-	-0-
95534	O-TOLUIDINE	141,326	-	-0-
8001352	TOXAPHENE (CHLORINATED CAMPHENE)	S672	-	-0-
120821	1,2,4-TRICHLOROBENZENE	34[illegible]	-	-0-
79005	1,1,2-TRICHLOROETHANE	127,S134	-	-0-
79016	TRICHLOROETHYLENE	127,S336	T	13
95954	2,4,5-TRICHLOROPHENOL	-0-	-	-0-
88062	2,4,6-TRICHLOROPHENOL	-0-	-	-0-
121448	TRIETHYLAMINE	221,S152	-	-0-
1582098	TRIFLURALIN	-0-	-	-0-
540841	2,2,4-TRIMETHYLPENTANE	-0-	-	-0-
108054	VINYL ACETATE	278	-	-0-
593602	VINYL BROMIDE	349	-	-0-
75014	VINYL CHORIDE	178	R	21
75354	VINYIDENE CHLORIDE (1,1-DICHLOROETHYLENE)	266	O	19
1330207	XYLENES (ISOMERS AND MIXTURE)	127,S318,1501	O	6
95476	O-XYLENES	127,S318	-	-0-
108383	M-XYLENES	127,S318	-	-0-
106423	P-XYLENES	127,S318	-	-0-
-0-	ANTIMONY COMPOUNDS	-0-	-	-0-
-0-	ARSENIC COMPOUNDS (INORGANIC INCLUDING ARSINE)	-0-	-	-0-

-0-	BERYLLIUM COMPOUNDS	-0-	-	-0-
-0-	CADMIUM COMPOUNDS	-0-	-	-0-
-0-	CHROMIUM COMPOUNDS	-0-	-	-0-
-0-	COBALT COMPOUNDS	-0-	-	-0-
-0-	COKE OVEN EMISSIONS	-0-	-	-0-
-0-	CYANIDE COMPOUNDS	-0-	-	-0-
-0-	GLYCOL ETHERS	-0-	-	-0-
-0-	LEAD COMPOUNDS	-0-	-	-0-
-0-	MANGANESE COMPOUNDS	-0-	-	-0-
-0-	MERCURY COMPOUNDS	-0-	-	-0-
-0-	FINE MINERAL FIBERS	-0-	-	-0-
-0-	NICKEL COMPOUNDS	-0-	-	-0-
-0-	POLYCYLIC ORGANIC MATTER	-0-	-	-0-
-0-	RADIONUCLIDES (INCLUDING RADON)	-0-	-	-0-
-0-	SELENIUM COMPOUNDS	-0-	-	-0-

EPA reference number corresponds to attached reference sheet

R= Reference - EPA promulgated method
T= Tentative - EPA method development complete; EPA reference avaiable
D= Development - EPA method currently under development
O= Other - Method development completed by organization other than EPA
N= None - No reference available

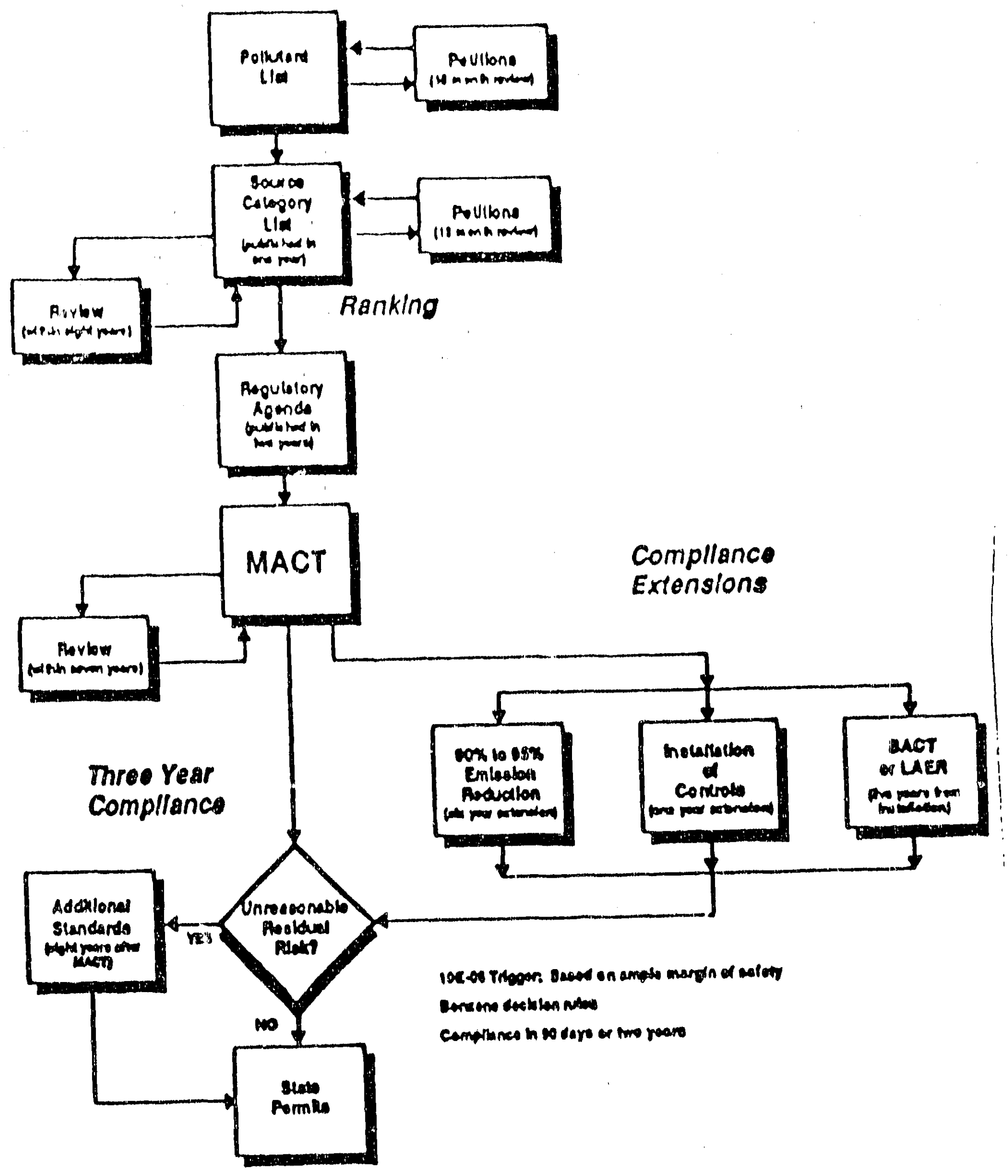

Figure 1. Title II Air Toxics Strategy to be Followed by the EPA.

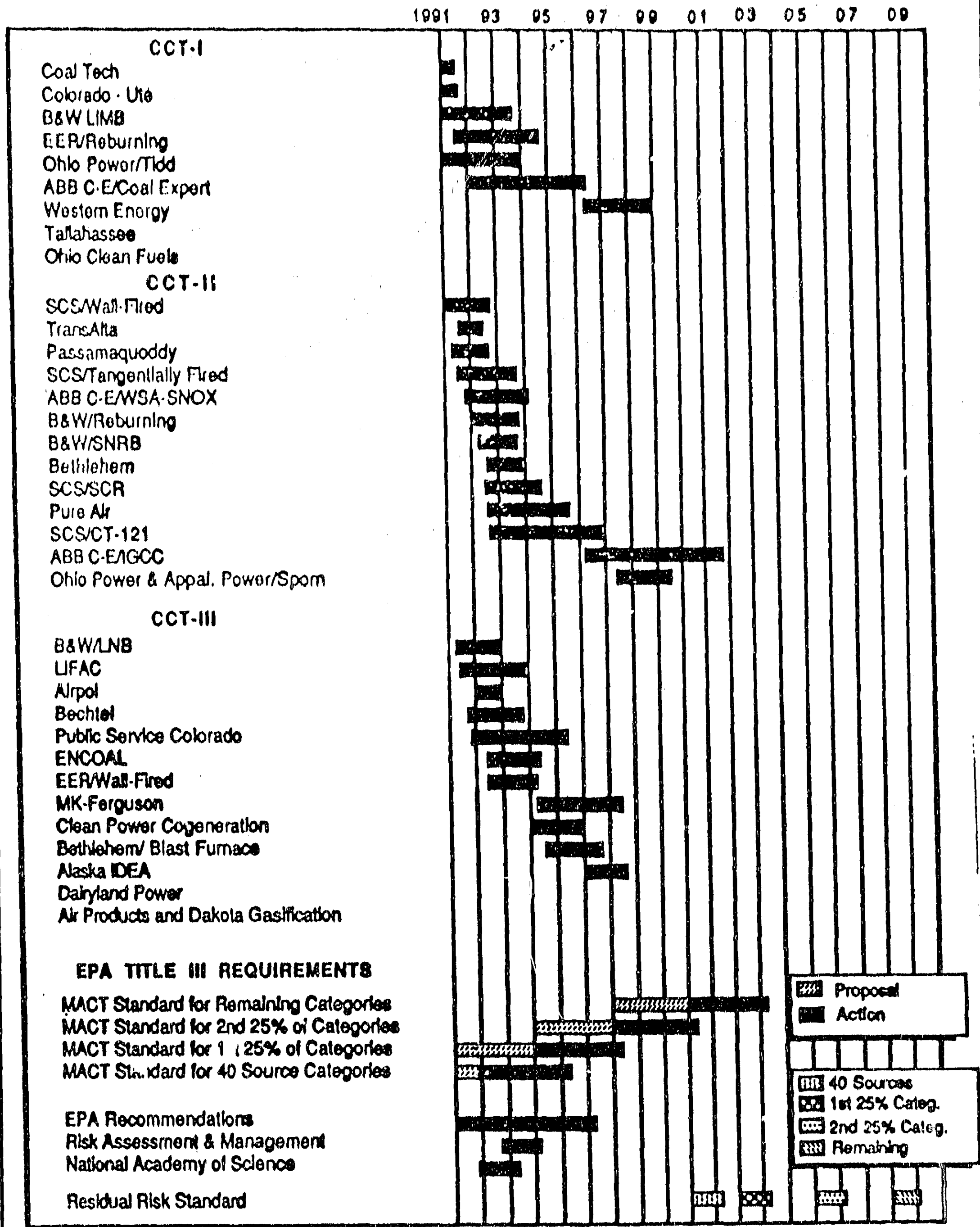

Figure 2. Clean Coal Technology Demonstration Project Operating and Title III Regulatory Schedules.

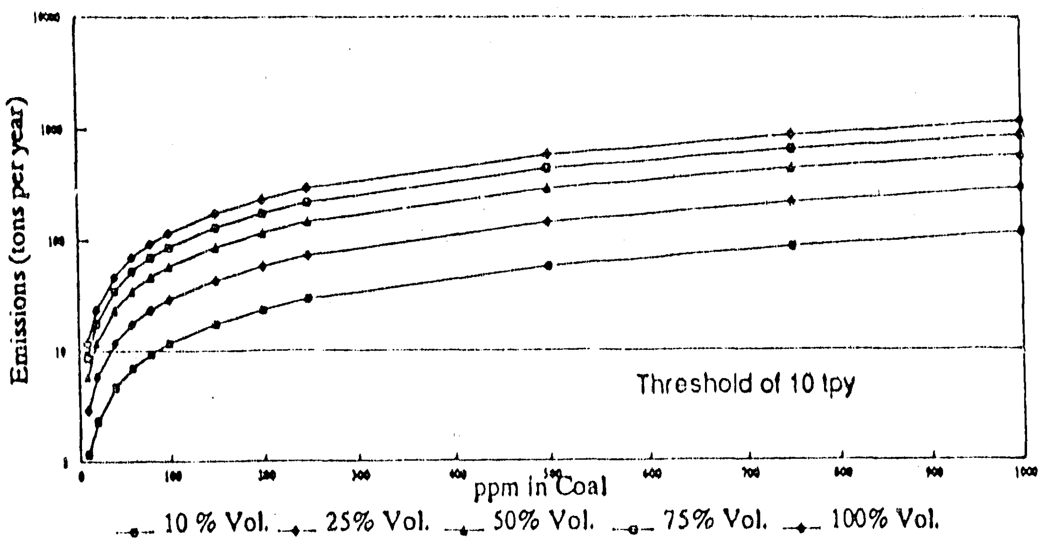

Figure 3. Estimated Stack Gas Emissions As a Function of Trace Element Concentration and Volatility.

END

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