

Environmental Engineering: A Review of Issues, Regulations, and Resources

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Background:

Increased attention to both local and global environmental issues over the past few decades has resulted in heightened focus on these issues. This has also increased the workload, knowledge base, and responsibilities of environmental professionals. Issues range from the impact of pollution on human health and global climactic change to national security risks and nuclear fuel processing. Considerations to health and environment are made with attention to economics and commerce. Known cases exist where deleterious financial impact resulted from negative consumer perceptions of a corporation's environmental or human-health related policies. "Green marketing" wears a friendly neighbor label, and instills a barrier-to-entry against competitive products.

The costs associated with environmental and personal safety policies (the "compliance burden") pose real challenges to corporations. However, these costs serve as prudently invested dollars when weighed against the ramifications of environmental policy inaction, whether as regulatory fines or market share loss. Adherence to the various Codes of Federal Regulations (CFR) that apply to US industries can prevent public embarrassment, and help maintain customer loyalty. This chapter will focus on statutes and mandates of the US Environmental Protection Agency (USEPA) enforceable by various Federal Regulations. It will discuss the state of engineering and management tools available for managing corporate compliance, and provide numerous on-line resources suitable for in depth investigation of each topic.

As a quick reference, government agencies that have important bearing on the environment can be contacted via the following sites:

- The US Environmental Protection Agency www.EPA.gov
- The Nuclear Regulatory Commissions www.nrc.gov
- The US Department of Energy www.doe.gov
- Occupational Health & Safety (OSHA) www.osha.gov
- Health and Human Services www.hhs.gov

Section 1: The Clean Air Act

<http://epa.gov/air/caa/>

The Clean Air Act (CAA) establishes monitoring and reporting mechanisms, air pollution inventories and reporting thresholds, and economic incentives for controlling and/or reducing pollutant emissions from manufacturing sectors of all types. The CAA monitors the National Ambient Air Quality Standards (NAAQS) via State Implementation Plans (SIP) to ensure consistent air quality for all US residents. Each SIP adheres to the requirements of the CAA by assigning applicable air pollutants to one of two categories:

- Criteria Pollutants represent those for which a primary (personal safety threshold) or secondary (environmental threshold) limit exists. These limits reflect the efforts of experimental science, with criteria pollutants including common pollutants and those that are harmful based on long-term cumulative exposure, or that typically occur in very low amounts.
- Hazardous Air Pollutants (HAPs) are those manifesting known carcinogenic effects or exhibiting other extreme pathological symptoms in humans and/or in the environment.

Criteria Pollutants

US regions that experience criteria pollutant concentrations at or below defined threshold levels receive "attainment zone" classification. Roughly 90 million Americans currently live in non-attainment zones. These residents frequently suffer from pollutant effects of smog, whose adverse effects on human health include shortness of breath and may include increased asthma frequencies in young children. Long-term exposure often permanently impairs human respiratory and immune system function, and can lead to death; historical records indicate that 4,000 Londoners died in December 1952 due to smog exposure.

Smog contains high concentrations of ground level ozone (O₃). Ozone naturally exists at high (stratospheric) altitudes, but VOCs and other criteria pollutants found in gasoline, organic solvents, and paints promote ozone increases at ground level. Criteria pollutants include combustion products, particulates (of various sizes), and volatile organics. A full list of criteria pollutants is at EPA site:

http://epa.gov/oar/oaqps/peg_caa/pegcaa11.html

Hazardous Air Pollutants (HAPs)

HAP pose serious risk to humans and to the ecosystem if not controlled. Many volatile organic compounds (VOCs) help comprise this group, and are regulated within the National Emission Standards for Hazardous Air Pollutants (NESHAP). They are often carcinogens at low exposure levels, impact reproduction efficiency and fetal development, or yield serious injury or death upon even slight exposure. A current list of such pollutants is located within section b1) of the following site:

<http://epa.gov/air/caa/caa112.txt>

Since HAP chemical lists often change, this site should be revisited regularly. Delisting of certain chemicals (e.g. acetone) can have significant regulatory and fiscal ramifications. Listed HAP materials may be pure compounds, components of a chemical mixture, or a byproduct of a chemical reaction. Regardless of a facility's pollutant type, the pollutant must be categorized, i.e. its levels quantified and then compared to regulatory listings and de minimis reporting levels. If a facility emits criteria or other regulated pollutants in excess of specified levels, it is classified as a major source (described below). The major source thresholds vary by location and pollutant.

Material Safety Data Sheets (MSDS) are needed for all materials utilized and/or produced within a facility, whether as a raw material, an intermediate, or by-product, and must be available to assist in determining a chemical's standing relative to its level of hazard within several categories. When available, more detailed information is preferred.

To limit the risk of HAP exposure over time, the USEPA mandates that all major sources of such emissions operate under Maximum Achievable Control Technology (MACT) standards. The EPA intends to augment and add to the current list of MACT standards; additionally, there are "catch-all" regulations for all major sources. One such example is the "MACT Hammer," which allows states to implement MACT standards for industries not currently addressed by EPA definitions. A list of such MACT standards can be referenced at:

http://www.dep.state.pa.us/dep/deputate/airwaste/aq/permits/neshaps/hammer_table.pdf

To implement the CAA, the USEPA administers the National Emissions Standards for Hazardous Air Pollutants (NESHAP), as well as other classifications, in defining an emitter's standing under an enforceable Title Program. Where new sources of emissions are created, or where existing sources are modified, other regulations (including both New Source Review (NSR) and New Source Performance Standards (NSPS)) must be considered. Titles are defined as follows (courtesy www.EPA.gov).

Title I - Air Pollution Prevention and Control <http://epa.gov/air/caa/title4.html>

- Part A - Air Quality and Emission Limitations
- Part B - Ozone Protection (replaced by Title VI)
- Part C - Prevention of Significant Deterioration of Air Quality
- Part D - Plan Requirements for Non-attainment Areas

Title II - Emission Standards for Moving Sources <http://epa.gov/air/caa/title2.html>

- Part A - Motor Vehicle Emission and Fuel Standards
- Part B - Aircraft Emission Standards

- Part C - Clean Fuel Vehicles

Title III - General <http://epa.gov/air/caa/title3.html>

Title IV - Acid Deposition Control <http://epa.gov/air/caa/title4.html>

Title V - Permits <http://epa.gov/air/caa/title5.html>

Title VI - Stratospheric Ozone Protection <http://epa.gov/air/caa/title6.html>

Requirements associated with Title V ("Title 5") are of vital importance to industry. A facility's air permit defines the air pollutant threshold limits available to it. The permit declares essential operational parameters of the holder's facility with regard to product and raw material throughputs, and establishes the basic relationships between those throughputs and regulated pollutant emissions amounts.

Agencies grant permits to manufacturers or distributors generally based on one of three (3) regulated emitter definitions, as follows:

- **Major Source**
 - A stationary source having the potential to emit twenty-five (25) tons of total HAPs to the air per annum
 - A stationary source having the potential to emit ten (10) tons of a single HAP to the air per annum
 - A stationary source having the potential to emit one hundred (100) tons of any criteria pollutant to the air per annum
 - A stationary source having the potential to emit HAPs in greater quantities than regionally established thresholds. This addresses non-attainment zones, such as the "extreme non-attainment" zone in the Los Angeles basin (10 TPY).
- **Synthetic Minor Source**
 - A stationary source that accepts federally enforceable limitations on their operations (production) to maintain their emissions below major source thresholds
- **Minor Source**
 - A stationary source with potential to emit, for all pollutants, less than major source threshold limits.

Local and state regulations may further restrict emissions.

Details concerning the requirements involved with applying for Title V permits are explained within the EPA link: air/caa/title5.html.

Methodologies for Determining Air Emissions

The EPA allows either a simple, conservative estimation or a more precise and advanced approach to emissions estimation. As an example, facilities involved in the manufacture of limited products via a continuous process can obtain emission factors from experimental observation (e.g. stack testing) or via Continuous Emissions Monitoring Systems (CEMS). When experimental data are intended, the EPA defines appropriate, useable testing methods. Approved methods and their descriptions are available at:

<http://www.epa.gov/ttn/emc/tmethods.html>

Facilities unable to implement CEMS or to derive suitable experimental emission factors for their operations can utilize the factors and methods available at the EPA's Air Pollutant Emission Factor clearinghouse site, commonly referred to as CHIEF. Emission factors, free software, and other useful information are located at:

<http://www.epa.gov/ttn/chief>

In all cases, the emission factors and methods outlined in AP-42 (a compendium of the industry specific, USEPA emission factors available via the CHIEF site) provide conservative estimates, thereby yielding an auditable “worst case” inventory of air pollutants nationally and regionally. Manufacturers adhering to AP-42 likely overestimate air emissions.

The added expense attributable to an increased compliance burden resulting from inaccurate estimation of emissions, whether through administrative headcount or capital equipment, likely far exceeds the costs of implementing advanced methods for estimating air emissions. AP-42 can usually be excelled, and the variance between estimated emissions and actual emissions reduced considerably. Available environmental management information systems (EMIS) may or may not provide advanced methods for emissions estimation, and should be reviewed versus their use of AP-42 or better.

The Clean Air Act requires a revised permit for any change to a major source facility's "emissions fingerprint" resulting from the addition of physical emission points or the change of mode of operation (New Source Performance Standards, NSPS). All new and modified major sources of HAPs must comply with MACT standards.

These modifications may be positive or negative with regard to Title V permitted emission levels, but such a change requires an update to the air pollutant inventory under State (SIP) rules. Often, a net zero change in emissions can be achieved by combining parallel activities - one positively divergent, one negatively divergent. Substituting non-HAP for HAP classified solvents in cleaning operations is a simple example of a negatively divergent change.

The Miscellaneous Organic NESHAP (MON) is structured to reduce the floor levels of major sources and to reassess the definitions of and methods by which MACT standards and levels are achieved:

<http://www.epa.gov/ttncaaa1/t3/reports/mocmsidp.pdf>

Certain sites currently classified as minor emissions sources will find themselves reclassified as major sources under MON, and adherence to the requirements of the MACT guidelines posed by the major source classification will likely be capital intensive. It is recommended that manufacturers of VOC related products acquaint themselves with the MON, and make necessary preparations. Costs associated with major source classification within MON often range upwards of \$3-5 M per facility.

Title IV (Acid-Rain) and Title VI (Stratospheric Ozone) Considerations

1. **The Title IV (Acid Rain) Permit:** <http://epa.gov/air/caa/title4.html>

The environmental, health, and cultural impacts of acid rain were well documented in the late 20th century. Sulfur and nitrogen oxides combine with atmospheric water to form acids. The prevalence of mobile (e.g. automotive and aircraft) sources globally hints at the requirement for control of Title IV compounds and precursors. Automotive catalytic converters (<http://www.all-catalytic-converters.com/techtip1.html>) alleviate this issue (as well as those associated with smog formation) within the mobile source category, but are not the perfect solution to emissions problems. Within the stationary source category, acid rain forming compounds primarily result from combustion-based power plant facilities.

Title IV addresses "affected sources" which comprise "affected units." These affected units are subject to emissions reductions or limitations under Title IV, and are granted allowances per annum, with each allowance equal to one (1) ton of SO₂ per year. Under Title IV, facilities must document and report annually regarding their aggregate SO₂, NO_x, and precursor emissions. These amounts are determined by stack testing, with emissions factors subsequently calculated in units of pound of species emissions per pound of fuel combusted, per period of operation. Title IV thresholds are subject to penalty when exceeded. In the case of violation, the EPA can enforce a mandatory emissions reduction in the subsequent year to offset the excess emission value.

Power generation facilities are evaluated within the Title IV requirements versus baselines established within the National Acid Precipitation Assessment Program (NAPAP) Emissions Inventory. Source and unit types applicable under Title IV can be found at: <http://epa.gov/air/caa/caa402.txt>.

Emission allowances under Title IV are eligible for trading and/or carry forward, contingent upon adherence to EPA administrative and regulatory rules. Discussion of such activity can be reviewed at:

<http://www.epa.gov/airmarkt/articles/clearingtheair.pdf>.

2. The Title VI (Stratospheric Ozone) Permit <http://epa.gov/air/caa/caa602.txt>

Decreasing levels of stratospheric ozone (O₃) over the polar caps have led to the conclusion that a reduction in high-atmospheric (stratospheric) ozone levels will lead to increased skin cancers rates (caused by excessive, non-historical UV (β band radiation) exposure). Chlorine and other halogen-bearing hydrocarbons (typically chlorofluorocarbons, or “CFC”) defined as either Class 1 or Class 2 pollutants (<http://epa.gov/air/caa/caa602.txt>) comprise ozone-depleting substances. Glacial ice core samples indicate pre-industrial-age levels of atmospheric chlorine at < 1 ppb. By the late 20th Century, the concentration had reached 3.6 ppb. Continuation of current reduction efforts may return the earth's atmosphere to < 1 ppb levels shortly after year 2100. The following link provides a summary analysis of CFC/HCFC atmospheric conditions: <http://www.ccpa.ca/english/library/RepDocsEN/NERMEng/ozone.pdf>.

Operators must report all Class 1 and Class 2 compounds whether imported, exported, or manufactured. Additionally, users of non-essential (as determined by administrator review) Class 1 or Class 2 substances are prohibited from sale or transfer of such substances.

Numerous control technologies are available for the reduction of air emissions. Several examples are provided below, with general comments:

1. Oxidizers

Thermal oxidizers rely on high temperature combustion of VOC/HAP species to reduce emissions levels. Although often expensive, they provide destruction efficiencies often greater than 99.8%, and thus have a highly measurable return.

2. Condensers

Condensers condense volatile species present in the vapor stream resulting in sidewall condensation and reflux to the liquid phase. Vapor pressure data are used to predict control efficiencies as functions of temperature.

3. Scrubbers and Absorbers

Scrubbers capture particles, gases, and/or acidic vapors. In treating particulate matter, scrubbers remove particulates in mists of liquid (typically water), and transport the particles away from the vapor stream. In these cases, high flow rates of liquid mist droplets increase the removal efficiency of the solids. For gases, it is essential to select a liquid in which the gas is soluble and to use liquid and vapor flow rates that match the targeted capture percentage based on the system's solubility information. In both cases the liquid to vapor ratio is an important operating variable.

In acid gas removal, the scrubber employs a solid alkaline "sorbent" material mixed with water. The gas phase acid adsorbs onto the sorbent surface, forming a salt. Available sorbent surface area, vapor-liquid stream mixing, and reactivity will dictate the

effectiveness of such "dry sorbent injector" (DSI) scrubbers. Information on scrubbers can be found at:

<http://yosemite.epa.gov/oaqps/EOGtrain.nsf/DisplayView/NT000015AE?OpenDocument>

4. Biofilters

Although relatively new, biofiltration can sometimes be used for reduction of emissions and odors. Biofilters consist of microbes grown on porous media, and in small scale implementations, provide > 90% reduction.

5. Cogeneration

Several new technologies combine destructive oxidation technologies with co-generative site-based power facilities. The energy utilized in emissions oxidation can sometimes be reclaimed to yield economic benefits.

Help

In general, numerous professional consulting service providers can help prepare Title V permits, annual emissions inventory reports, and other state specific documents. A regional search within any Internet browser can identify potential candidates. The USEPA expects EMIS systems be implemented at all major source sites. Implementation of such systems typically constitutes the first requirement of an EPA corrective action plan. As stated above, more accurate estimation of emissions can lead to reduced compliance burden and potentially eliminate the need for source classification adjustment. In all cases, adherence to the full range of Federally Applicable Requirements (FAR), the crux of which are provided above, combined with the goal of maintaining operational flexibility, is a highly desired objective.

Section 2: Greenhouse Gases (GHG) and (Global Warming) Climactic Change

<http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissions.html>

No Clean Air Act regulations currently apply to greenhouse gas (GHG) emissions. The United States and other nations are conducting research on global warming while establishing the current air inventory of GHG.

Although few dispute that current industrial processes, automobiles, power production, etc. impact GHG levels, there is still much debate regarding human-induced and naturally occurring variations. Recently excavated ice core samples indicate that CO₂ levels are rising at a much faster rate than at any time in the past 400,000 years. Such cores show current atmospheric CO₂ levels of 380 ppmv, exceeding previous cyclical highs by roughly 18%. The following links to graphical data can assist in drawing conclusions.

- <http://www.grida.no/climate/vital/02.htm> (440,000 year CO₂ atmospheric measurements, Vostok ice sheet, Antarctica)

- <http://www.grida.no/climate/vital/06.htm> (recent data from Mauna Loa test site, altitude 4,000 meters)
- <http://www.grida.no/climate/vital/07.htm> (CO₂ levels, 1859 to present)

Section 3. The Clean Water Act <http://www.epa.gov/r5water/cwa.htm>

The Clean Water Act (CWA) provides quality standards (WQS) for surface waters in the United States. The CWA gives the USEPA the authority to implement pollution control and regulatory strategies. Water quality criteria (WQC) provide chemical specific numerical values of amount (magnitude), interval of test, and frequency of occurrence that must be met in tandem to meet the requirements of the WQS. For chemicals with WQC in existence at EPA, states and Indian tribes must also assign WQC (not necessarily of identical numerical value to the EPA metrics).

The EPA typically allows exemptions from the WQS for locations downstream of point source discharges (“stream mixing”) as well as for relatively rare conditions where a significant increase in flow diminishes water quality (for example: storm sewer flooding). Waivers based on mixing are regulated, and require that mixing zones do not extend throughout a body of water or from bank to bank of a river or stream. Additionally, waivers will not allow deleterious impact to designated use (DU) zones. A contiguous region meeting WQS must be maintained.

Designated use categorizations indicate the level of quality to which a community aspires; the level of “*existing use*” establishes a benchmark. The intent of the existing use delineation assures that no commercial, public, or private activity reduces water quality to sub-existing use levels, and regulating agencies will not authorize sub-existing use conditions (“Tier I rule”).

The EPA protects zones that significantly exceed current WQS from negative impacts, thus making it difficult to impact a water body while ensuring the quality remains above it’s the minimum. Prior to initiation of such an adverse activity, several criteria must be met as define under the “Tier II rule.” Certain waterways are designated as Outstanding National Resource Waters (ONRW), and no significant degradation in water quality is permitted for any significant period of time (“Tier III rule”). These three (3) “anti-degradation rules” provide high-level management metrics to regulating and enforcement bodies within the state, national, or regional levels.

Of note, infrequent measurements of water quality result in large statistical errors in estimation of performance versus WQS. When the available evidence indicates achieving WQS standards unlikely or impossible via application of source control technologies, the EPA imposes Total Maximum Daily Load (TMDL) levels of individual pollutant discharge from point sources. Unfortunately, application of TMDL rules does not typically result in achievement of WQS due to the large impact of non-point sources (e.g. soil runoff). Nonetheless, TMDL's for such defined pollutants as clean sediments, nutrients (nitrogen and phosphorus), pathogens, acids/bases, heat, metals, cyanide, and synthetic organic chemicals are enforced.

TDML caps are established, with margins of safety allotted, and completed facility TDML plans and strategies are provided to the EPA for approval or rejection. The period defined within a TDML plan does not necessarily have to equal one day, and a reserve for future polluting activities is typically comprehended. Approved agencies or parties will regularly audit site performance against a facility's TMDL plan.

The following figure (courtesy USEPA) highlights the key focus areas of the CWA:

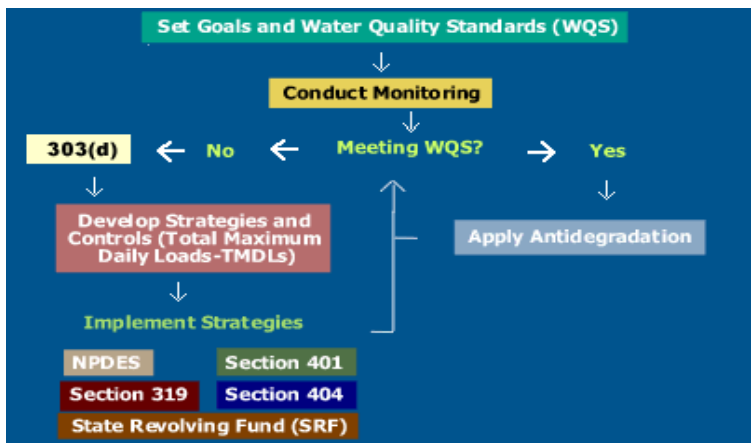


Figure 1: Water Quality Standards Flowchart

Although the CWA states that pollution discharge from point sources is illegal, it does allow for controlled discharges via the National Permit Discharge Elimination System (NPDES) permit. NPDES permits limit the levels of point source pollutant discharge allowable over defined periods (some sectors of industry are exempt. Consult <http://www.epa.gov/watertrain/cwa/cwa37a.htm>). Indirect discharges, i.e. those treated by a Publicly Owned Treatment Works facility (POTW)) prior to release, are not covered under the NPDES permitting program (see below).

The EPA defines Waste Load Allocations (WLA) to point source pollution sources (generally or specifically) which are then regulated against the defined TMDL (if applicable) established in the site NPDES permit. The EPA provides an example distribution of WLA within a TMDL plan at site

<http://www.epa.gov/watertrain/cwa/cwa35.htm>.

Often, NPDES permits are either granted as individual or general permits, and contain specific mass amounts of defined pollutants eligible for discharge (effluent limits at pipe end) from the permitted operation. To ensure compliance, internal auditing plans and quality control policies are defined. Further requirements for using best management practices, monitoring, and reporting are included.

Detailed information on NPDES permits is available at:

<http://www.epa.gov/watertrain/cwa/cwa40.htm>.

As with the CAA, the CWA establishes performance standards (the maximum effluent concentrations allowable) and control technology guidelines applicable to various per industries and sectors. These guidelines reflect data compiled from numerous industry sources, and define expected discharge levels as a function of Best Available Technology Economically Achievable (BAT or BATEA). More information on effluent streams is at:

<http://www.epa.gov/waterscience/guide/>.

For cases where application of BAT to effluent stream discharges will not meet the requirements of a water source's DU, and for which TMDL limits are not established, the permitting agency will apply Water Quality Based Effluent Limits (WQBEL). WQBEL includes an analysis of the level of effluent stream dilution required to retain DU levels. Where WQBEL's are employed, a high risk has been assigned to the water source, and economics will often be secondary to technology.

For Publicly Owned Treatment Works (POTW) primary and secondary levels of sequential treatment specifications exist. The former involves the settling and filtering of solids (activated sludge). The following table provides typical limits imposed on secondary treatment criteria:

Table 1. Publicly Owned Treatment Works Water Allowance Limits (General)

<u>Pollutant</u>	<u>Effluent Limit / 7 Day Average</u>	<u>Effluent Limit / 30 Day Average</u>
5-day BOD	45 mg/lit	30 mg/lit
Total Suspended Solids (TSS)	45 mg/lit	30 mg/lit
PH	N/A	6-9
Removal Specification	N/A	85% of BOD 5 and TSS

The EPA offers supplemental information regarding activated sludges involving biosolids, including rules and standards; see site: <http://www.epa.gov/watertrain/cwa/cwa42.htm>.

Due to heavy rainfall, wastewater overflows from sewers or industrial facilities may result in underperformance versus WQS. Nevertheless, affected sewer systems, typically "Combined Sewer Overflow" (CSO) or "Municipal Separate Storm Sewer Systems" (MS4), remain subject to NPDES regulations. CSO systems, found in older residential or municipal areas, allow transportation of both rainwater and raw sewage within a common stream; MS4 systems separate the two flows. Attention to the public health challenges posed by CSO sewers focus on control of pathogen dispersion. From NPDES

perspectives, CSO systems are restricted from discharging untreated sewage during periods of dry weather. NPDES regulates MS4 sewers that discharge to surface waters due to the potential for the water line to contain various levels of contaminants such as metals, oils, and pesticides. Permits for MS4's tend to focus on response planning and "design against failure" rather than on actual effluent stream concentrations. More information is available at:

<http://www.epa.gov/watertrain/cwa/cwa46.htm>.

Industrial sites may or may not require individual NPDES permits for storm water runoff pertaining to overflow drainage into surface water or MS4 sewage systems. Frequently, these conditions will be covered under NPDES documentation via the site's storm water pollution prevention plan (SWPPP):

<http://cfpub.epa.gov/npdes/stormwater/indust.cfm>.

SWPPP Phase I applies to industrial facilities and to construction sites affecting more than five (5) land acres, while SWPPP Phase II regulations affect those construction sites affecting between 1-5 acres. SWPPP are expected to provide plans for minimization of soil erosion, protect vegetation and wetlands, and define runoff-source points to standing water.

Additionally, a Spill Prevention Control and Countermeasure (SPCC) plan may be required at facilities where oil materials are stored. Importantly, edible oils are often included in this designation. SPCC is discussed in more detail in Section 9.

Non-point source runoff is the major source of water pollution in the United States and is regulated by CWA Section 319. Topsoil runoff from farms and pastures represents the major source of this pollution. Contrasting the federal position on point sources, the EPA provides grants ("319 funds") and other modes of assistance and incentive to primary contributor states. The EPA's objective is to curtail pollution from such erosion sources and to define auditable levels of watershed TMDL. For more on non-point pollution, utilize the EPA CWA link:

<http://www.epa.gov/watertrain/cwa/cwa52.htm>.

The "Wetland Protection Program," administered by the Army Corps of Engineers (see CWA section 404 and <http://www.epa.gov/owow/wetlands/facts/fact10.html>), addresses the displacement of dredged or fill-material into defined wet areas such as bottomland hardwood swamps, intermittent streams, or oceans. The Army Corps of Engineers has ultimate authority for defining a Section 404 wetland, and for assuring compliance within section 404 boundaries. The wetland protection program requires that any commercial activity requiring the destruction of existing wetlands be essentially dependent on the presence of water. If not, the activity will be relocated to an unprotected area. Prior to construction on a protected wetland area, demonstration of destruction mitigation plans along with a wetland replacement strategy and/or a plan for improving an existing wetland must be presented.

Special attention is given waters that are directly threatened or do not meet WQS. These

receive Section 303(d) or Section 305 (threatened or impaired waters) classification. Section 303(d) includes those surface water sources impacted by pollutants, whereas “non-pollutants” impair Section 305 waters. Where the source of aquatic life impairment is unclear, the source receives Section 303(d) classification. Waters classified as threatened or impaired require biennial progress reporting, with prioritization of TMDL levels and WQC established accordingly.

Section 401 certification ensures that all states indicate compliance status under the CWA. By requiring such a certification, states downstream of the discharge can become involved in the certification and permitting processes.

<http://www.epa.gov/watertrain/cwa/cwa58.htm>

By their nature, hydroelectric dams cause great variance between existing and designated use (DU) classifications. Construction of these structures often leads to frequent and aggressive debate, with environmental and ecological affects weighed against economic and human safety considerations.

Section 4: Spill Prevention Control and Countermeasures Act (SPCC)

The SPCC, ultimately a component of the Clean Water Act, focuses on prevention of oil spills into US waters or shorelines. To minimize the impact of spills, the SPCC requires filing of Facility Response Plans (FRP) under its Oil Pollution Regulations.

SPCC addresses owners or operators that drill, produce, gather, store, use, process, refine, transfer, distribute, or consume oil and oil products. With such a broad classification, de minimis standards are established that set maximum vessel or throughput quantities. The SPCC defines threshold EPA reportable event levels as:

- Two spills in excess of forty-two (42) gallons each within any given twelve month period
- One spill in excess of 1,000 gallons

Highlights, de minimis standards, and additional information including for FRP guidelines, are available through site:

<http://www.epa.gov/oilspill/spccrule.htm>.

Section 5: Nuclear Power Generation

Currently, Nuclear Energy serves as the second largest source of electrical power in the United States (behind coal). Nuclear sources are inherently clean, but significant risks and therefore governmental regulations apply to the waste disposal methods.

The Nuclear Regulatory Commission (NRC: <http://www.nrc.gov/>) oversees all permitting, guidelines, and definition of operational requirements via the Office of Nuclear Reactor Regulation. A guideline review is available at:

<http://www.nrc.gov/what-we-do/regulatory/guidance-dev.html>.

Nuclear reactor facilities undergo hazardous waste management procedures every 12-24 months. Removal of old fuel rods generates approximately 2,000 metric tons of used radioactive material annually (the National Energy Institute presents the analogy of one football field covered to the depth of five (5) yards during the last forty years.

Based on laws against the proliferation of nuclear weapons, this waste material cannot be recycled, and is assigned a once-through single use designation. Department of Energy policies as administered by the Office of Worker Protection Programs and Hazards Management (WPPHM) can be consulted at:

<http://tis.eh.doe.gov/WPPHM/regs/pluton.pdf>.

The Office of Environmental Management (OEM) maintains the Department of Energy's waste management policies. Two discrete levels of nuclear wastes are considered:

1) *Low Level Waste*

- a. Radioactive byproducts of NRC-licensed or DOE-permitted activities that are not high-level waste.
- b. *Radioactivity, containing mostly beta and gamma emissions, persists for 5 to 50 years;,, contains elements with atomic numbers less than that of uranium (92), and is eligible for disposal via authorized independent or government approved facilities, as determined by the Low Level Waste Disposal Facility Federal Review Group (LFRG)*

2) *High Level Waste*

- a. Irradiated nuclear fuel ("spent fuel"), plus both liquid products of reprocessing and the solids into which such liquids have been incorporated.

Contains numerous radioactive materials of high levels of radiation and with long half-lives. These materials are generated either through nuclear power generation or Department of Defense activities. In general they are assigned for disposal at the US Government Yucca Mountain National Depository, a site selected in large part because of National Security concerns.

Lessons Learned: 3-Mile Island and Chernobyl

The incident at Unit 2 of the 3-Mile Island (Pennsylvania) reactor during March 28 to April 1, 1979 led to the formation of the Institute of Nuclear Power Operations. The INPO sets objectives, guidelines and criteria for all US-based nuclear power generating facilities. In 1985, this group established the National Academy for Nuclear Training, which accredits all plant operators and supervisors.

In April 1986, fundamental flaws in Soviet reactor designs, combined with procedural human error, resulted in a steam explosion and the expulsion of 5% of the Chernobyl-4 (Ukraine, USSR) reactor core into the atmosphere. This disaster sparked a review of (especially Russian) reactor designs and further emphasized the need for strictly enforced operational standards, guidelines, and policies. Differences between current “East” and “West” reactor designs can be reviewed at the following site:

<http://users.owt.com/smsrpm/Chernobyl/RBMKvsLWR.html>.

Next Generation Designs – VHTR Reactors

Very High Temperature Reactors (VHTR), currently being developed, address not only energy generation but, via high temperature cracking, also provide a relatively cheap source of molecular hydrogen. Hydrogen is proposed as an alternate fuel source for automotive and industrial power. Significantly, no greenhouse gases are produced by VHTR methods, unlike current hydrogen generation methods (e.g. methane reaction).

In a cogeneration scheme, a fraction of the electricity generated by the VHTR also serves to power hydrogen/oxygen separation processes and on site storage facilities. When combined with an adequate logistics system, this hydrogen can serve as a fully clean, renewable energy source for personal or industrial use.

Development scale health and safety reviews, combined with economics and logistics confirmations, will dictate the future of VHTR reactors. Current technical opinion posits a plausible initial use by 2030. For further review of this and other nuclear power generation roadmap technologies, consult site:

<http://energy.inel.gov/gen-iv/default.shtml>.

Section 6. OSHA <http://www.osha.gov/>

The Occupational Safety and Health Act has the objective of protecting workers’ lives and health by the enforcement of policies, regulations, and guidelines defining working and workplace conditions. OSHA lists regulations and guidelines for compliance via the sites:

http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=0&p_keyvalue=

and

<http://www.osha.gov/html/comp-guides.html>,

respectively.

Employers must operate within these guidelines except for rare exceptions (variances). Variance types include:

1) Temporary

- a. Issued when an employer-operator cannot meet the requirements of an OSHA regulation due to a lack of available staff, equipment, or materials. Employers governed by a state-run worker protection program must contact their local plan representative for such variance, but operators that span geographic areas or states that include OSHA regulated regions must apply directly through OSHA.

2) Permanent

- a. Issued to an employer that demonstrates pre-existing methods superior to OSHA requirements. In attaining a permanent variance, the employer must his or her workforce of the intention to seek a variance, and allow for an employee hearing if requested.
- b. At any time within six (6) months of the award of a permanent variance, employees and employers maintain the right to petition for the rescinding of the variance. OSHA may also follow this course at its own volition.

3) Experimental and Other Variances

- a. Granted by the Secretary of Health and Human Services (HHS) to ascertain the impact of a operations changes that require variance. This experimental variance is intended to improve existing OSHA methods.
- b. Because of National Security reasons, the Department of Defense may hold other variances.

Variances are not retroactive. During the period of operation prior to receipt of a variance, if issued, OSHA may provide an Interim Order, allowing continued activity based on current methods. Details of such an interim order are subject to site-publication and employee-employer review.

Section 7: The "Superfund" Law <http://www.epa.gov/superfund/>

The "Superfund Law" derives from citizen concerns over the health impacts of decades of accumulated hazardous wastes within or near communities. More accurately labeled The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Superfund governs the removal and destruction of toxics and also establishes disposal procedures via the Office of Superfund Remediation Technology Innovation (OSRTI). Prioritization activities are within the jurisdiction of the OSTRI.

The Superfund Amendments and Reauthorization Act (SARA) provides guidelines to improve Superfund enforcement methods and criteria. SARA also refines the Hazardous

Rankings System, by OSTRI prioritizes remediation activities. Rules and Regulations under the Superfund and its SARA amendment are accessible at

<http://www.epa.gov/superfund/action/index.htm>.

Section 8: EPCRA (Emergency Planning and Community Right to Know Act)

<http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/EPCRA.htm?OpenDocument>

EPCRA, also known as "Title III of SARA," protects local communities from the hazards of toxic pollutant discharge. EPCRA mandates regulations surrounding the maintenance and site availability of such forms as Material Safety Data Sheets (MSDS), Toxic Chemical Release forms, and Emergency and Hazardous Chemical Inventory forms

(<http://www4.law.cornell.edu/uscode/42/ch116schII.html>).

Under EPCRA, State Emergency Planning Commissions (SEPC) and local emergency planning councils must be formed. EPCRA ensures the documentation of quantity and location of hazardous materials present in excess of Toxic Substance Controls Act (TSCA) thresholds. SARA Title III information must be submitted to state and local (including Fire) agencies under SARA sections 312 and 313.

EPCRA, in combination with the Pollution Prevention Act (PPA), administers the Toxic Release Inventories (TRI) program. Industry and federal facilities emitting toxic materials must report on annually released quantities under SARA section 313 (Form R). Although the EPA does not host a site containing all TRI materials, versions of this document can be obtained via the Government Printing Office (<http://www.access.gpo.gov/>). An executive summary, including requirements for submittal to the TRI via Form R submittals, is available at

<http://www.epa.gov/tri/tridata/tri01/press/executivesummarystandalone.pdf>.

Section 9: Toxic Substances Control Act (TSCA)

<http://www.epa.gov/region5/defs/html/tsca.htm>

More than 75,000 chemicals enter, are manufactured within, and/or are consumed within the United States each year. The TSCA provides methods for categorizing newly created and existing chemicals, and supplements the Clean Air Act and the Toxic Release Inventory portion of EPCRA. TSCA assists in quantifying types and amounts of chemicals both produced and released to the environment annually.

Commercial activities that result in the creation of new chemicals must receive authorization from the USEPA prior to production or distribution. To receive such authorization, a Pre-Manufacture Notice (PMN) must be filed with the EPA's Office of

Pollution Prevention and Toxic Substances. An example PMN, provided by USEPA, can be reviewed at:

<http://www.epa.gov/opptintr/newchems/pmnforms.pdf>.

Additionally, regulations and guidance regarding the requirements for submitting PMN's are available at: <http://www.epa.gov/opptintr/newchems/tscaman2.pdf>. For a listing of Toxic Substance categories as defined within the Chemicals on Reporting Rules (CORR) database, access:

<http://www.unh.edu/ehs/CS/Resources/TSCA-CORR-By-CAS.pdf>.

Three chemical groups receiving special attention from communities include:

- Asbestos:
<http://www4.law.cornell.edu/uscode/15/ch53schII.html>
- Indoor Radon:
<http://www4.law.cornell.edu/uscode/15/ch53schIII.html>
- Lead Exposure Reduction:
<http://www4.law.cornell.edu/uscode/15/ch53schIV.html>

Section 10: Resource Conservation and Recovery Act (RCRA)

<http://www.epa.gov/rcraonline/>

Administered by the Office of Solid Wastes (OSW), the RCRA establishes regulations regarding the effective handling of spilled, leaked, or otherwise improperly disposed wastes. The RCRA also manages hazardous wastes from their origin to disposal, and also oversees garbage and industrial waste handling. Example wastes not covered under RCRA are nuclear (see above), medicinal, and animal.

[Http://www.epa.gov/epaoswer/osw/topics.htm](http://www.epa.gov/epaoswer/osw/topics.htm) provides an information source addressing those wastes covered under the RCRA, including regulations surrounding underground storage tanks (UST).

Section 11: Summary

The daily tasks of compliance management in the face of potentially changing government regulations are facilitated by a strong industry compliment of consulting expertise. Additionally, software packages of varied types are available to assist in automating difficult compliance tasks.

Environmental Engineering issues span a wide gamut of essential technologies and

requirements. Ensuring compliance with government regulations, though never a glorified chore, nonetheless provides a necessary function that ensures the protection of interests ranging from the economic to the vital.

Engineers and scientists need to monitor the healthy progress of developing nations, assist in defining the directions of new and necessary technologies, and protect our citizens and ecosystems.

The human societal impact of a dearth of environmental stewardship is too great to gamble.

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