



**Implications of Federal Programs for
Green Production Work Standards:
U.S. Environmental Protection Agency
and
U.S. Department of Energy**

BRIEFING PAPER

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by

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Introduction

Both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) are responsible for activities that directly or indirectly affect the operation of industrial facilities, which in turn have implications for the job requirements of front-line production workers:

- The regulatory compliance and enforcement actions of the EPA are drivers of “green” skill requirements of workforces in regulated industries.
- The standards and energy-efficiency initiatives of the DOE aimed at industrial production processes and products may be reflected in enhanced or new skill requirements for workers in a broad range of industries, but especially in those that are most heavily energy (and carbon) intensive.

The purpose of this briefing paper, first, is to provide an overview of these two key government agencies, in particular, the programs and responsibilities that affect the environmental and energy profiles of manufacturing activities. It then reflects on the likely or potential implications of these programs for current and future state skill requirements of production workers related to “green” production, i.e., industrial processes subject to EPA-monitored and enforced regulations or energy-efficiency standards and applications promoted or overseen by the DOE.

United States Environmental Protection Agency

EPA Origins and Mission

Born in the wake of a growing concern about environmental pollution in the 1960s, the U.S. Environmental Protection Agency (EPA)¹ officially came into existence on December 2, 1970. In July 1970, President Nixon sent Reorganization Plan Number 3 to Congress, which included a proposal to create a “strong independent agency” to establish and enforce environmental protection standards, conduct environmental research, assist others combating environmental pollution, and help develop and recommend to the President new policies for environmental protection. EPA consolidated in one agency a variety of federal research, monitoring, standard-setting and enforcement activities to ensure environmental protection that hitherto had resided in several other federal agencies and programs.

Earlier in 1970, landmark environmental legislation, the National Environmental Policy Act (NEPA), also was signed into law. NEPA established national environmental policy and goals for the protection, maintenance, and enhancement of the environment, and provided a process for implementing these goals within the federal agencies. In addition, it established the Council on Environmental Quality (CEQ) to give the President expert advice on environmental matters. EPA assists the

¹ EPA's URL is www.epa.gov.

representatives, reviewing records and reports, taking photographs, collecting samples, and observing facility or site operations.

3. **Compliance incentives** encourage government, industry and business facilities to assess their overall compliance with environmental requirements and voluntarily correct and report compliance programs. This includes self-auditing, environmental management systems, pollution prevention, small business policy, small communities policy and other innovations. EPA also encourages facilities to find and disclose violations to the Agency.
4. **Enforcement** activities carried out by EPA offices hold persons or companies legally accountable for either civil or criminal violations of the nation's environmental laws and regulations. The responsibilities for various actions that make up EPA's enforcement program are divided among different Headquarters offices, the EPA Regions, and state agencies.

Major Statutes Relevant to Manufacturing

A number of statutes authorize EPA's regulatory responsibilities to meet environmental goals in several critical areas:³

- *Clean Water*: get raw sewage out of the water; cut pollution from animal waste; reduce polluted water runoff; assure clean drinking water for all communities; clean up great waters that matter to communities, e.g., Chesapeake Bay
- *Clean Air*: cut toxic air pollution in communities; reduce air pollution from largest sources, including coal fired power plants, cement, acid and glass sectors
- *Climate and clean energy*: assure compliance with greenhouse gas reporting rule; encourage GHG emission reductions through settlements; target energy sector compliance with air, water and waste rules
- *Protect people from exposure to hazardous chemicals*: prevent releases of hazardous chemicals that threaten public health or the environment; press for clean up of hazardous sites in communities; reform chemical management enforcement and exposure to pesticides.

Some of the most important of these statutes relevant to EPA's regulation of manufacturing industries include:

Clean Air Act (CAA) *42 U.S.C. §7401 et seq. (1970)* Comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, it authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants (Section 112). 1990 Clean Air Act Amendments revised

³ See <http://www.epa.gov/lawsregs/laws/index.html>.

Section 112 to require issuance of technology-based standards for major sources and certain area sources. “Major sources” are defined as stationary source or group of stationary sources that emit or have the potential to emit 10 tons per year or more of a hazardous air pollutant or 25 tons per year or more of a combination of hazardous air pollutants. An “area source” is any stationary source that is not a major source. For major sources, Section 112 requires EPA to establish emission standards that require the maximum degree of reduction in emissions of hazardous air pollutants—commonly referred to as “maximum achievable control technology” or “MACT” standards.

Clean Water Act (CWA) *33 U.S.C. §1251 et seq. (1972)* Establishes the basic structure for regulating discharges of pollutants into the nation’s waters and regulating quality standards for surface waters.⁴ EPA has implemented pollution control programs such as setting wastewater standards for industry and water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA’s National Pollutant Discharge Elimination System (NPDES) permit program controls discharges; industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

Compliance areas include pretreatment of wastewater, state and EPA periodic inspections and audits of Publically Owned Treatment Works (POTW), and pretreatment implementation programs to ensure that programs are properly implemented. Areas of particular importance to manufacturing industries include:

- *Biosolids* (POTW sludge)—when treated and processed, sewage sludge becomes biosolids, which can be recycled and applied as fertilizer to soils. EPA conducts inspections of POTW and other industrial facilities that generate, store, transport and dispose of biosolids
- *Oil spill prevention*—inspections of facilities that store oil to ensure that the facility satisfies requirements designed to prevent oil spills
- *Industrial storm water*—inspections of facility operations subject to storm water regulations including construction sites; industrial sites, and municipal storm sewage systems.

Resources Conservation and Recovery Act (RCRA) *42 U.S.C. §6901 et seq. (1976)* Gives EPA the authority to control hazardous waste from the “cradle-to-grave.” This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to

⁴ The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, which was significantly reorganized and expanded in 1972, its name changed to “Clean Water Act” with amendments in 1977.

address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. The 1984 the Federal Hazardous and Solid Waste Amendments to RCRA focused on waste minimization and phasing out land disposal of hazardous waste as well as corrective action for releases. Specific areas covered by the RCRA include:

- *Hazardous waste*—EPA and its regulatory partners inspect facilities which generate, transport, treat, store or dispose of hazardous waste to verify compliance with applicable regulations
- *Underground storage tanks*—EPA conducts inspections to assure compliance with technical standards and corrective actions when a release has occurred
- *Recycled used oil*—inspections of recycled used oil facilities to assure compliance
- *Hazardous waste import/exports*—requires prior notification of shipment of wastes, collects export manifests documenting individual shipments of waste, and receives export annual reports from the regulated community.

Toxic Substances Control Act (TSCA) 5 U.S.C. §2601 *et seq.* (1976) Provides EPA with authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures.⁵ TSCA addresses the production, importation, use, and disposal of specific chemicals including polychlorinated biphenyls (PCBs), asbestos, radon and lead-based paint. EPA maintains a Toxics Release Inventory (TRI)—a public database including information about the release of toxic chemicals from manufacturing plants into the environment through the air, water, and land—and controls for industrial and commercial sources of toxics. The latter includes rules covering over 80 categories of major industrial sources, such as chemical plants, oil refineries, aerospace manufacturers, steel mills, such as smaller sources (e.g., dry cleaners, commercial sterilizers, secondary lead smelters, chromium electroplating facilities).

Various sections of TSCA provide EPA authority to:

- Require pre-manufacture notification for “new chemical substances”
- Require testing of chemicals by manufacturers, importers, and processors where risks or exposures of concern are found
- Issue Significant New Use Rules (SNURs) when it identifies a "significant new use" that could result in exposures to, or releases of, a substance of concern
- Maintain the TSCA Inventory, which contains more than 83,000 chemicals; as new chemicals are commercially manufactured or imported they are placed on the list.

⁵ Certain substances are generally excluded from TSCA, including, among others, food, drugs, cosmetics and pesticides.

- Require those importing or exporting chemicals to comply with certification reporting and/or other requirements.
- Require reporting and recordkeeping by persons who manufacture, import, process, and/or distribute chemical substances in commerce.
- Require any person who manufactures (including imports), processes, or distributes in commerce a chemical substance or mixture and who obtains information which reasonably supports the conclusion that such substance or mixture presents a substantial risk of injury to health or the environment to immediately inform EPA.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or Superfund) *42 U.S.C. §9601 et seq. (1980)* Provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Gives EPA power to seek out those parties responsible for any release and assure their cooperation in the cleanup. Through various enforcement tools, EPA obtains private party cleanup through orders, consent decrees, and other small party settlements, and can recover costs from financially viable individuals and companies once a response action has been completed. EPA also cleans up orphan sites when potentially responsible parties cannot be identified or located, or when they fail to act.

The Superfund Amendments and Reauthorization Act (SARA) of 1986 reauthorized CERCLA to continue cleanup activities around the country. Several site-specific amendments, definitions clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. EPA is authorized to implement the Act in all 50 states and U.S. territories. Superfund site identification, monitoring, and response activities in states are coordinated through the state environmental protection or waste management agencies.

Noise Control Act *42 U.S.C. §4901 et seq. (1972)* Establishes a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. Inadequately controlled noise presents a growing danger to the health and welfare of the Nation's population, particularly in urban areas. The major sources of noise include transportation vehicles and equipment, machinery, appliances, and other products in commerce. The Act serves to (1) establish a means for effective coordination of Federal research and activities in noise control; (2) authorize the establishment of Federal noise emission standards for products distributed in commerce; and (3) provide information to the public respecting the noise emission and noise reduction characteristics of such products. While primary responsibility for control of noise rests with State and local governments, Federal action is essential to deal with major noise sources in commerce, control of which

require national uniformity of treatment. EPA is directed by Congress to coordinate the programs of all Federal agencies relating to noise research and noise control.

Application to Manufacturing Industries⁶

Many if not most business sectors are affected by a variety of environmental statutes and regulations. EPA provides compliance assistance on a sector-by-sector basis in order to efficiently reach facilities with similar operations, processes or practices, similar environmental problems and impacts and similar compliance issues. Manufacturing sectors with facilities that could be subject to significant compliance requirements include:

- Aerospace
- Automotive (motor vehicle assembly industry; automotive repair facilities)
- Cement
- Chemical Manufacturing (inorganic; organic; paints, varnishes, and related; pharmaceuticals; agricultural chemical, pesticide, and fertilizers)
- Electronics and Computers
- Food Processing
- Furniture and Fixtures
- Lumber and Wood Products
- Metals (iron and steel; nonferrous metals; metal casting; fabricated metal products)
- Petroleum Refining
- Printing (lithographic; screen)
- Pulp and Paper
- Rubber, Plastics and Resins
- Stone, Clay, Glass and Concrete Products
- Shipbuilding and Repair
- Textiles

As table 1 illustrates, many of these industries manage significant quantities of TRI chemical wastes, most of which are recycled, recovered for energy use, or treated. The table also shows the quantities of TRI chemicals each industry reported it released (in 2006) into the air as emissions, discharged into water or disposed as waste, and the wastes they generated and managed—reported in EPA’s *National Biennial RCRA Hazardous Waste Report (BR)*—considered hazardous to the environment and human health.

⁶ See <http://www.epa.gov/lawsregs/bizsector/index.html>.

Table I
Environmental Performance Data for Selected Manufacturing Industry Sectors

Industry	Emissions of Criteria Air Pollutants (tons) ^{1*}	Releases of Chemicals Reported to 2006 TRI ^{2**}					Hazardous Waste*		Recycling, Energy Recovery, or Treatment ^{**} (lbs)
		Total (million lbs)	Air Emissions (million lbs)	HAPS % of Air Emissions ³	Water Discharges (lbs)	Waste Disposals (million lbs)	Generated (tons)	Managed (tons)	
Cement	576,000	10.9	8.8	57%	3,100	2.1	17,000	31,000	1.1 billion
Chemical Manufacturing	1.5 million	519.2	187.0	50%	37.5 million	294.8	23.8 million	26.1 million	9.8 billion
Food & Beverage Manufacturing	454,000	150.1	47.0	70%	77.3 million	25.9	3,100	2,400	543 million
Forest Products	1.5 million	233.8	185.4	86%	19.1 million	29.2	136,000	396,000	1.4 billion
Iron & Steel	755,000	293.1	4.1	34%	2.3 million	286.7	1.4 million	1.3 million	459.1 million
Metal Casting	75,000	40.1	3.2	66%	68,000	36.8	30,000	28,000	126.3 million
Oil & Gas (Petroleum Refining)	832,000	72.3	42.8	44%	22.0 million	7.5	5.1 million	5.1 million	1.2 billion
Paint & Coatings	10,300	5.7	4.0	88%	24,000	1.6	146,000	148,000	122.5 million
Shipbuilding & Ship Repair	5,900	2.5	2.1	56%	10,000	0.36	7,000	6,000	7.2 million

* Source: US EPA, Sector Strategies Division, *2008 Sector Performance Report* [EPA 100-R-08-002]. Data are for 2005.

** Source: US EPA, Sector Strategies Division, *2008 Sector Performance Report, Supplement* (February 2009). Data are for 2006.

¹ Criteria air pollutants (CAPs) from combustion: largest components include sulfur dioxide (SO₂), nitrogen oxide (NO_x), particulate matter (PM); data on CAPs come from EPA's National Emissions Inventory (NEI)

² TRI: EPA's annual Toxics Release Inventory based on reports filed by more than 23,500 facilities across the country.

³ HAP: Hazardous Air Pollutants

The challenges manufacturers face in managing these wastes while achieving compliance to EPA regulations are reflected in table 2, which presents several recent examples of companies' violations of EPA regulations, and the subsequent financial penalties they were subject to and corrective actions they have been required to take. The examples cover a broad spectrum of industries—chemicals,

pesticides, food processing, iron and steel products, concrete and electronics—and types of environmental violations (CAA, CWA, RCRA, EPCRA, TSCA).

In addition, EPA has made addressing air emissions from petroleum refineries a national priority. Since March 2000, EPA has entered into 26 settlements covering 90 percent of the nation's petroleum refinery capacity, including 102 refineries in 30 states and territories. The refiners have agreed to pay \$7 million in civil penalties, invest more than \$5 billion in control technologies, and perform supplemental environmental projects over \$67 million. Full implementation will result in significant reductions of nitrogen oxide and sulfur oxide, and additional reductions of benzene, volatile organic compounds and particulate matter.

Compliance tools for industry. The EPA provides several compliance assistance tools aimed at helping businesses comply with environmental regulations:

- ***Compliance Assistance Centers:***⁷ The EPA sponsors partnerships with industry, academic institutions, environmental groups, and other agencies to launch sector-specific web-based Compliance Assistance Centers. Through websites, telephone assistance lines, fax-back systems, and e-mail discussion groups, among other things, the Centers attempt to help businesses, college and universities, local governments, and federal facilities understand federal environmental requirements and save money through pollution prevention techniques.
- ***Sector Notebooks:***⁸ A unique set of profiles containing information for specific industries and governments. For each covered sector, a notebook includes a comprehensive environmental profile, industrial process information, pollution prevention techniques, pollutant release data, regulator requirements, compliance and enforcement history, government and industry partnerships, and innovative pollution control and prevention programs. Most of the industry sector notebooks appear to have been produced in the mid-to-late 1990s, though some are dated after 2000 through 2005.
- ***Compliance Assistance and Inspection Publications:***⁹ Guides, manuals, fact sheets and brochures that pertain to individual sectors or specific regulations.

⁷ See <http://www.assistancecenters.net>.

⁸ See <http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/index.html>.

⁹ See <http://www.epa.gov/compliance/resources/publications/assistance/index.html>.

Table 2
Selected Examples of EPA Compliance and Enforcement Violations and Settlements
Involving Manufacturing Facilities

Company (location)	Products	Violations	Penalties	Corrective Actions
Edge Tech Industries (Davenport, IA)	Printed-circuit boards	Violated EPCRA* for 2006, 2007, 2008: failure to submit reports to EPA and state authorities of regulated chemicals released into environment	\$26,000 civil penalty	Filed required reports in full compliance of EPCRA
Air Products LLC (Pasadena, TX)	Chemicals	RCRA violations for sending hazardous spent acid stream to nearby Agrifos fertilizer plant	\$1.5 million civil penalty	Agrees to manage spent acid on-site and not ship it to Agrifos or other plants
Bayer CropScience LP (Kansas City, MO)	Pesticides (35 million lbs annually)	CAA violation—failure to implement risk management program to prevent and respond to chemical accidents and releases	\$37,790 civil penalty	Spending \$100,000 on air monitors to aid chemical release detection
Western Sugar Cooperative (Scottsbluff, NE)	Sugar beet processing	CWA violation—excessively high discharges of fecal coliform bacteria in wastewater	\$56,736 civil penalty	\$350,000 plant upgrades to cut pollution, save water and energy
Lifoam Industries (Vernon, CA)	Polystyrene	CAA and state air quality violations	\$450,000	Must vent all manufacturing emissions through air pollution control device
Cardi Materials, LLC (Warwick, RI)	Concrete	CWA violations—unpermitted process water and stormwater discharges and failure to develop and implement a spill prevention control and countermeasure plan	\$55,000 civil penalty	\$168,500 project to eliminate all process water discharges; comprehensive environmental audit and additional monitoring and reporting; hire certified stormwater management personnel; provide training for all operational employees
McWane Inc. (28 facilities in 14 states; HQ: Birmingham, AL)	Cast iron pipes, valves, fittings, fire hydrants, propane & compressed air tanks	> 400 violations of federal and state environmental laws: includes CAA, CWA, RCRA, EPCRA, TSCA and several state laws	\$4 million	7 environmental projects valued at \$9.1 million; corporate-wide environmental management system (EMS); and audit to evaluate EMS adequacy**

* EPCRA=Emergency Planning and Community Right-to-Know Act; requires companies of certain size to submit annual report (Form R Reports) to EPA and state authorities of regulated chemicals that their facilities release into the environment through routine activities or as a result of accidents, which also include information regarding waste management, recycling and reduction of these toxic chemicals. Provides important information for emergency planners and responders, and residents of surrounding communities.

** In the past, McWane divisions and facilities have been the subject of criminal investigations resulting in five federal prosecutions, \$23 million in criminal fines and penalties, \$5 million worth of environmental projects, and prison terms for company executives.

Sources: US EPA Compliance and Enforcement 2010 News Releases

EPA Training Programs

The EPA provides training for federal, state and tribal environmental enforcement agencies. This training is offered through the National Enforcement Training Institute (NETI) via NETI Online. It is only open to regulatory or law enforcement professionals of Federal, state, local or tribal governments, e.g., government investigators, inspectors, attorneys, case developers and technical staff. NETI also provides funding to external organizations with similar missions to help extend the reach of environmental enforcement training at the local level. However, EPA does not offer training programs to managers or workers in the industry sectors covered by its regulations.¹⁰

Clean Production Programs

The EPA has several programs for researching, developing and promoting clean/green technologies and production processes, which would have wide application to manufacturing industries:

Green Chemistry Program.¹¹ Green chemistry is the use of chemistry for pollution prevention. Specifically, it entails the use of chemical technologies that reduce or eliminate the use and generation of hazardous substances during the design, manufacture, and use of chemical products and processes. The following summarizes the main green chemistry principles that are put forward as a guide to chemists for designing chemical products and processes:

- Design chemical products to be less hazardous to human health and the environment
- Use feedstocks and reagents that are less hazardous to human health and the environment
- Design syntheses and other processes to be less energy and materials intensive
- Use feedstocks derived from annually renewable resources from abundant waste
- Design chemical products for increased, more facile reuse or recycling.

Green chemistry, which emphasizes source reduction and prevention of chemical hazards, is considered to be at the top of a “sustainable chemistry hierarchy” which also includes the reuse or recycling of chemicals, treatment of chemicals to render them less hazardous, and proper disposal of chemicals.

¹⁰ See <http://www.epa.gov/compliance/training/neti/>.

¹¹ See <http://www.epa.gov/greenchemistry/>.

The EPA's Green Chemistry Program, under the Office of Chemical Safety and Pollution Prevention,¹² includes the Presidential Green Chemistry Challenge Awards to recognize outstanding examples of green chemistry, support of partnerships with academia, industry, scientific societies, trade organizations, national laboratories, research centers, and other government agencies to promote pollution prevention through green chemistry, and various projects and programs including educational activities and research and development.

Clean Processes. The mission of EPA's Clean Processes Branch (CPB)¹³ is to develop and demonstrate clean technologies for pollution prevention, recycling and reuse, and to estimate their environmental consequences through industrial ecology approaches such as life cycle assessment. Major research emphases relevant to manufacturing includes green chemistry and engineering, metals recovery and recycling, and pervaporation.¹⁴

- ***Green chemistry and engineering***—research aimed at developing and demonstrating cleaner synthesis for commodity and specialty chemicals through improved catalysis, use of solvent-free or alternative reaction media and raw materials.
- ***Metals recovery and recycling***—aims to address pollution risk by advancing the understanding of the chemistry and the engineering of hybrid separations based on combinations of sorption, electric field, and membrane technologies. Its goal is to identify new and novel pollution prevention applications, provide tools and information to evaluate the performance of hybrid unit operations, and to increase end-user confidence in these technologies through small-scale demonstrations.
- ***Pervaporation***—research to advance the scientific understanding, performance, and engineering application of pervaporation-based separation processes for pollution prevention and waste treatment. The aim is to develop new cost-effective separation (membrane) technologies that enable the incorporation of pollution prevention efforts into production processes and attempts to remediate existing contaminated sites and waste streams.

¹² The Green Chemistry Program had its origins in the Pollution Prevention Act of 1990, after which the Office of Pollution Prevention and Toxics launched a model research grants program called "Alternative Synthetic Pathways for Pollution Prevention," which provided unprecedented grants for research projects that include pollution prevention in the design and synthesis of chemicals. In 1993, the program expanded to include other topics, such as greener solvents and safer chemicals, and renamed "Green Chemistry."

¹³ See <http://www.epa.gov/research/NRMRL/std/cppb/>.

¹⁴ Other research programs include watersheds environmental and impact analysis, chemical process simulation for waste reduction (the WAR algorithm), and quantitative structure activity relationship project, which seeks to develop methodologies and software to estimate toxicity of compounds from their molecular structure.

Industrial Media Research. The EPA’s Industrial Multimedia Branch (IMB)¹⁵ supports research to develop, demonstrate, and evaluate timely and integrated innovative engineering and scientific approaches to reduce air, water and land toxic pollution generated by the production, processing, and use of materials. These include research on metal finishing, metal forming, lead paint and soil abatement, industrial process pollution preventing modeling and fuel cells, computer-based pollution prevention (P2) tools, and computer-aided process engineering. It also sponsors the Common Sense Initiative, a cooperative effort of government, industry, environmental groups, and others to find cleaner, cheaper, smarter approaches to environmental management in industrial sectors. It’s PARIS II (Program for Assisting the Replacement of Industrial Solvents, Version 2) software tool is designed to enable the cost-effective replacement of industrial solvents harmful to worker health and the environment.

- ***Metal Forming***—a research program in metal products manufacturing developed to identify environmental problems and deliver solutions for environmental solutions based on sustainable technology to the industry, which is one of the top ten polluting sectors. Its goal is to advance pollution prevention opportunities, including reduction in the use of toxics, prevention of the formation of large volumes of wastewater, hazardous waste of air emissions containing toxic pollutants, and improvements in energy conservation. Recent projects include research on advanced casting technologies, environmentally friendly metal working fluids and alternative surface cleaning technologies.
- ***Metal Finishing***—various environmental research projects to support the metal finishing industry.
- ***Industrial Process Pollution Prevention Modeling***—research in modeling of industrial processes for pollution prevention applications. This includes developing computer software tools for the user community to self-assess their pollution prevention options with environmental concerns as a major parameter.

Green Suppliers Network.¹⁶ The Green Suppliers Network is a collaboration of the EPA and the U.S. Department of Commerce’s National Institute of Standards and Technology’s Manufacturing Extension Partnership (NIST MEP). It works with large manufacturers to engage their small and medium-sized suppliers in low-cost technical reviews that focus on process improvement and waste minimization. EPA provides program support and funding for the network. It includes technical reviews coordinated through NIST MEP, teaching suppliers about “lean and clean” manufacturing methods to increase energy efficiency, identify cost-saving opportunities and optimize resources to eliminate waste.

¹⁵ See <http://www.epa.gov/nrmrl/std/mtb/index.html>.

¹⁶ See <http://www.epa.gov/greensuppliers/index.htm>.

E3: Economy, Energy and Environment.¹⁷ Evolving out of the Green Suppliers Network program, E3 is a coordinated federal and local technical assistance initiative to help manufacturers adapt sustainability practices. Beginning as a pilot program in 2009, it became official on September 25, 2010, with the signing of a memorandum of understanding between EPA, the Department of Energy, the Department of Commerce, the Department of Labor, and the Small Business Administration.

E3 provides technical assessments of production processes (reviews, audits, evaluations, and post-assessment recommendations) and training in the four key areas of lean production, clean production, energy, and greenhouse gas emissions. These efforts target opportunities to maximize energy efficiency, reduce environmental wastes, identify ways to reduce carbon emissions, and promote sustainable manufacturing practices and growth, while reducing business costs. A principal goal is to create incumbent workers certified in emerging green industries.

Two pilot projects are currently being completed under the E3 program:

- Columbus, OH—federal partners are coordinating to conduct technical assessments and provide training through work with six manufacturers, the city government, the Solid Waste Authority of Central Ohio, and American Electric Power. The project has identified energy savings of \$1.7 million, environmental savings of \$2.6 million, over 250,000 pounds of water pollutants avoided, and solid waste reductions of 24,000 pounds.
- San Antonio, TX—the EPA, the Department of Commerce, CPS Energy, and the city government are working with six manufacturers. The project has resulted in a local detention equipment manufacturer realizing increased energy efficiency, including \$85,000 in potential energy savings, reduced annual electric consumption of 159,000 Kwh, reduced monthly electric demand of 48 kw, and reduced annual natural gas usage of 36,000 CCF.

United States Department of Energy

DOE Mission and Origins

The U.S. Department of Energy (DOE),¹⁸ established in 1977, can trace its roots back to the Manhattan Project, and the Atomic Energy Commission (AEC) created after the War to oversee the nuclear weapons program—and later nuclear power—for the nation.¹⁹ The DOE's overall mission is to advance the national, economic, and

¹⁷ See <http://www.epa.gov/greensuppliers/e3.html>.

¹⁸ The DOE's URL is www.energy.gov.

¹⁹ The Department of Energy Organization Act of 1977 (P.L. 95-91, 91 Stat. 565), which President Carter signed on August 4, 1977, after the oil crisis, created the Department of Energy, which assumed the

energy security of the United States. This includes promoting scientific and technological innovation in support of this mission and to ensure the environmental cleanup of the national nuclear weapons complex.

Although the DOE is somewhat larger than the EPA, only a relatively small division within it, the Office of Energy Efficiency and Renewable Energy (EERE)²⁰ contains programs directly relevant to manufacturing and skill standards. EERE's mission is to promote the development and use of more energy efficient and renewable energy technologies throughout the U.S. economy. This includes support of high-risk, high-value research and development critical to the nation's energy future that would not be sufficiently conducted by the private sector acting on its own.

Program activities are conducted in partnership with the private sector, state and local government, DOE national laboratories, and universities. EERE also works with stakeholders to develop programs and policies to facilitate the deployment of advanced clean energy technologies and practices. Major programmatic divisions include biomass, building technologies, federal energy management, geothermal, fuel cell technologies, industrial technologies, solar energy technologies, vehicle technologies, weatherization, and wind and hydropower technologies.

Industrial Technologies Program

Industry accounts for more than one-third of all the energy used in the United States. Natural gas and petroleum are the largest energy sources used in energy, followed by electricity and coal. The DOE Industrial Technologies Program (ITP)²¹ has principal responsibility to improve the energy intensity of the U.S. industry through coordinated research and development, validation, and dissemination of innovative energy efficiency technologies and practices. Its main goals are to help industry save energy and money, increase productivity, and decrease carbon emissions.

ITP works with industry through a competitive solicitation process, providing financial assistance to selected research, development and demonstration projects that can dramatically accelerate the pace of technology innovation. This includes:

- Conducting R&D on new energy efficient technologies
- Supporting commercialization of emerging technologies

responsibilities of the Federal Energy Administration, the Energy Research and Development Administration (ERDA), the Federal Power Commission, and programs of various other agencies. The department began operations on October 1, 1977. In 1974, AEC was replaced by the Nuclear Regulatory Commission (NRC) to regulate the nuclear power industry, and ERDA was established to manage the nuclear weapon, naval reactor, and energy development programs.

²⁰ See <http://www.eere.energy.gov/>.

²¹ See <http://www1.eere.energy.gov/industry/>.

- Providing plants with access to proven technologies, energy assessments, software tools, and other resources
- Promoting energy and carbon management in industry.

The ITP oversees the following program areas:

- ***Energy-Intensive Industries.***²² ITP supports collaborative R&D partnerships in eight critical energy intensive industries—they require a large amount of heat and energy per unit of product to physically or chemical transform materials—such as steel, aluminum, chemicals, forest products, metal casting, petroleum refining, and mining. Collectively, these industries supply 90% of the materials vital to our economy, produce \$1 trillion in annual shipments, directly employ over 3 million people, and indirectly provide 12 million jobs at all skill levels.
- ***Crosscutting Technologies.***²³ ITP supports R&D to improve efficiency of technologies that are common to many industrial processes and can benefit multiple industries. Because of the widespread application of these crosscutting systems, even small improvements in their efficiency can yield large energy savings. These include combustion, distributed energy, energy-intensive processes, fuel and feedstock flexibility, industrial materials for the future, nanomanufacturing, and sensors and automation.
- ***BestPractices.***²⁴ ITP works with U.S. industry to implement energy management practices in industrial plants. To meet the diverse needs of U.S. industry, this program provides a number of resources for corporate executives, plant managers, technical staff, and the general public.
- ***Industrial Assessment Centers (IACs).***²⁵ ITP supports centers at 26 participating universities across the country, to where local teams of engineering faculty and students provide no-cost energy assessments to eligible small- and medium-sized manufacturers. An industrial assessment is an in-depth assessment of a plant site, its facilities, services and manufacturing operations. It involves a thorough examination of potential savings from energy efficiency improvements, waste minimization and pollution prevention, and productivity improvement.
- ***Superior Energy Performance.***²⁶ This is a joint effort of ITP and the U.S. Council for Energy-Efficient Manufacturing to conduct Energy Management Demonstration projects. A voluntary, industry-designed certification program, its purpose is to give companies a framework to focus on managing and improving energy performance.

²² See http://www1.eere.energy.gov/industry/program_areas/industries.html.

²³ See http://www1.eere.energy.gov/industry/program_areas/crosscutting_technologies.html.

²⁴ See <http://www1.eere.energy.gov/industry/bestpractices/conducting.html>.

²⁵ See <http://www1.eere.energy.gov/industry/bestpractices/iacs.html>.

²⁶ See http://www1.eere.energy.gov/industry/program_areas/.

Training and Related Services

The ITP BestPractices program provides tools, training and resources for plant managers to assess and utilize efficient, new technology to achieve energy savings at their plants. This includes helping managers conduct energy audits and assessments, which entail collecting energy and facility data and performing an analysis of opportunities, as well meet their training needs. The program also makes available Qualified Specialists, trained in BestPractices assessment and analysis software tools, to help facilities identify ways to improve system efficiency.

In addition, BestPractices offers system-wide and component-specific training programs to help managers run their plants more efficiently. Training is offered throughout the year and around the country. Training sessions range from skills for managing motors and optimizing pumping systems to ways for saving energy in data centers. The training curricula include a variety of courses aimed at developing skills for managing energy use in compressed air systems, data centers, fan systems, motor systems, process heating, pumping systems, and steam systems.

Implications for Manufacturing Skill Standards

The programs and activities of the EPA and DOE directly and indirectly affect the environmental and energy-use profiles of manufacturing industries. As the premier environmental regulator in the nation, the EPA's compliance and enforcement actions can have significant consequences for manufacturing firms, which need to adopt practices and invest in technologies that prevent or mitigate environmental hazards, or face serious financial penalties. Both manufacturing managers and workers therefore need a working knowledge of the regulations, how they affect production facilities and processes, and skills in evaluating and managing environmental wastes and hazards.

EPA's green chemistry, clean processes, industrial multimedia research programs and DOE's promotion of industrial energy-efficiency technologies and practices are non-regulatory. Nevertheless, they help promote the innovation and diffusion of green/clean technologies and practices in manufacturing facilities. These in turn can determine requirements for new, green enhanced skills of existing occupations or green new and emerging occupations.²⁷

²⁷ Green enhanced skills occupations and green new and emerging occupations are two of three general occupational categories in a U.S. Department of Labor-sponsored report that describes the "differential consequences of green economy activities and technologies on occupational performance." The first category refers to impacts on the work and worker requirements of existing occupations. The latter refers to unique work and worker requirements, which results in the generation of new occupations. The third category includes "green increased demand occupations," which refer to increases in the employment demand for existing occupations resulting from green economy activities. See Erich C. Dierdorff, Jennifer J. Norton, Donald W. Drewes, et al. *Greening of the World of Work: Implications for Of*NET®-SOC and New and Emerging Occupations*. Prepared for the U.S. Department of Labor, Employment and Training Administration, Office of

EPA—Regulatory Compliance Skills

EPA's compliance assistance programs for industry are mainly aimed at business owners and managers, and, as earlier noted, its compliance and enforcement training programs are not available to private sector employees. Nevertheless, its regulatory activities directly and significantly influence the skill requirements of both managers and front-line workers in manufacturing plants needed to effectively comply with environmental regulations. These include:

- *Knowledge of the major regulatory statutes and their application to manufacturing processes in a wide range of industries.* The emphases on particular statutes may vary from industry to industry—employees would need to learn which are relevant to their specific industry and employer. However, as tables 1 and 2 illustrate, multiple statutes may apply to a single employer, depending on what they produce, and many manufacturing sectors, especially those that are energy and emissions intensive, generate large quantities of hazardous materials and chemical emissions and discharges covered by multiple environmental laws.
- *Knowledge of EPA tools and resources available to help businesses comply with environmental regulations.* The EPA recognizes that many companies, especially small and medium-sized enterprises, may not have sufficient capabilities and resources needed to cost-effectively identify, evaluate, and manage environmental hazards, to meet the standards established by environmental laws. Employers and their employees therefore need to be knowledgeable about the various compliance assistance programs and tools (compliance assistance centers, sector notebooks and other relevant literature, software and web-based tools, self-audit tools, etc.) EPA makes available to help businesses in their compliance efforts.
- *The capability to conduct or assist in environmental audits, evaluations and assessment, on a normal, day-to-day basis, and in response to accidents involving hazardous materials (e.g., chemical spills).* The ability of employees to identify, monitor, and assess potential or existing environmental violations resulting from the use of hazardous materials and chemicals within facilities and at the point of production, should be the first line of defense for employers in their efforts to comply with environmental regulations. This includes knowledge of audit protocols and ability to use self-auditing and evaluation tools.
- *The capability to identify and implement environmental remediation options.* Frontline workers need to be trained in the procedures and protocols necessary to mitigate or prevent environmental hazards or respond rapidly, safely, and effectively to environmental accidents when they occur. This could also include

Workforce Investment, Division of Workforce System Support. Raleigh, NC: National Center for O*NET Development (February 12, 2009).

knowledge and assessment of pollution control devices and other equipment for managing hazardous materials and wastes.

For example, the EPA conducts inspections of facilities or sites to gather information to determine whether they are in compliance with environmental regulations (except the Clean Air Act). These inspections involve site-visits, interviewing facility or site representatives, reviewing records and reports, taking photographs, collecting samples, and observing facility or site operations. The Clean Air Act requires evaluations rather than inspections, which entails looking at all regulated pollutants at all regulated emission units, and addressing the compliance status of each unit, as well as a facility's continuing ability to maintain compliance at each unit. Specifically, an evaluation could include a review of all required reports and underlying records at a facility; an assessment of air pollution control devices and operating conditions; observation of visible emissions; a review of facility records and operating logs; and, a stack test if there is no other way to determine compliance with emission limits.

As table 2 illustrates, failure to pass these inspections or evaluations could result in substantial civil penalties and costly remedial actions. It seems self-evident that it would be in an employer's self-interest if it was able to conduct self-evaluations (as well as monitor their own operations, collect and process data, and maintain necessary records), to assess its own compliance with federal environmental regulations, determine and implement remediation options, and hence, more easily pass muster in EPA's inspections and evaluations. Moreover, the advantages of involving trained front-line production workers in all stages of this process should be obvious. That is, maintaining a workforce trained with environmental assessment and remediation skills should be considered an important element of any manufacturer's compliance strategy.

This is suggested by the case of Cardi Materials LLC, a concrete manufacturer in Warwick, RI. As noted in table 2, in 2010, Cardi was cited for Clean Water Act violations involving unpermitted process and storm water discharges and failure to develop and implement a spill prevention control and countermeasure plan. Aside from having to pay a \$55,000 penalty, it was required to implement a \$168,500 project to eliminate the process water discharges and conduct a comprehensive environmental audit, as well as other monitoring and reporting. Most notably, to carry out these requirements, Cardi was required to hire certified stormwater management personnel and provide training for all its operational employees!

EPA—Clean Production Skills

EPA's clean production programs, while not tied to its regulatory compliance and enforcement functions, could also have important implications for "future state" skill requirements in clean/green manufacturing. Green chemistry options, metal

recovery and recycling technologies, and integrated innovative engineering and scientific approaches to reduce air, water and land toxic pollution, developed by EPA-supported research programs, have obvious implications for the work of engineering and scientific personnel in manufacturing facilities. However, the implementation of more advanced, cleaner technologies and production processes by manufacturers also would affect the job requirements and skills, and training needs, of front-line workers—enhancing the skill requirements for existing production workers and perhaps creating new occupations based on the new technologies and production processes.

The value of training frontline workers in enabling manufacturers to adopt new, sustainable practices is highlighted in the E3 Initiative. As mentioned above, E3 provides technical assessments of production processes and training in the key areas of lean production, clean production, energy, and greenhouse emissions. More significantly, as already noted, one of E3's principal goals is to "create incumbent workers certified in emerging green industries."

DOE—Clean Energy Skills

Outside its responsibilities to clean up contaminated sites and dispose the radioactive waste byproducts of nuclear weapons production, nuclear power naval vessels and commercial nuclear energy production, the DOE has no environmental oversight or regulatory authority. In contrast to the EPA's regulatory activities, the DOE's energy and energy efficiency programs are mainly developmental and promotional. Participation of companies in them is voluntary, largely motivated by the potential of reducing of energy costs in their operations and production processes, which can improve their profitability and competitiveness. That is, manufacturers have a compelling self-interest in introducing clean energy practices and technologies into their operations, which includes training both managers and frontline workers in the a variety of skills and practices to achieve these gains.

In particular, frontline workers can play a critical role in conducting industrial audits and assessments of production facilities and processes, to evaluate energy use, areas of energy waste and emissions leakage, and suggest options for enhancing energy-efficiency and reducing energy-related (carbon) emissions. For example, at a DOE Industries of the Future "show-case" integrated steel mill (circa 2000), union members reportedly identified carbon emissions leakage in the mill's coke oven and recommended improvements —subsequently implemented—to the oven's doors, which mitigated the emissions losses.²⁸

²⁸ Reported to the author by United Steel Workers members, including local union health and safety reps, in a visit to the Burns Harbor, IN steel mill, now owned by ArcelorMittal. The Industries of the Future (IOF) program, part of the DOE's former Office of Industry Technology (OIT), was defunded during the Bush Administration. The DOE Industrial Technology Program replaced the OIT as the lead in promoting industrial energy efficiency.

DOE's crosscutting technologies program, aimed at improving the efficiency of technologies common to many industrial processes, could require enhancement of existing job skills or creation of new types of jobs, for example, in the areas (as listed above) of combustion, distributed energy, next generation energy-intensive materials processing (e.g., in steel, aluminum, paper, and chemical manufacturing), fuel and feedstock, industrial materials for the future, nanomanufacturing, and sensors and automation, which warrant further examination.

Similarly, DOE's BestPractices program includes a focus on system-wide and component-specific training programs (e.g., motors, compressed air systems, data centers, steam systems, etc.) to help managers improve the energy-efficiency of their production facilities. The training curricula and skill requirements associated with this program, in particular, perhaps should be referenced in—if not applied to—the MSSC GPM skill standards and curricula development.