INHERENTLY SAFER TECHNOLOGY: THE CURE FOR CHEMICAL PLANTS WHICH ARE DANGEROUS BY DESIGN

I. INTRODUCTION

On December 8, 1941, President Roosevelt, in a speech requesting Congress to declare war on the Empire of Japan, proclaimed December 7, 1941 to be "a date which will live in infamy."[1] The deadly surprise attack at Pearl Harbor may be fading from the living memory of most Americans. However, the events of September 11, 2001 will be another day in American history that will surely live in infamy.

The attacks on September 11, 2001 were shocking to the American public.[2] Yet, they should not have been a surprise.[3] Evidence of Islamic extremists' intent to kill Americans was widely known.[4] Bombings of U.S. Embassies, the attack on the U.S.S. *Cole*, the downing of U.S. helicopters in Somalia, and the bombing of the World Trade Center should have put the United States on notice.[5]

Since the attacks on September 11, Americans live in a

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1. Franklin Roosevelt, Address to Congress Requesting Declaration of War with Japan (Dec. 8, 1941), http://www.fdrlibrary.marist.edu/tmirhdee.html.

2. *See* NAT'L COMM. ON TERRORIST ATTACKS UPON THE UNITED STATES, THE 9/11 COMMISSION REPORT EXECUTIVE SUMMARY 2 (2004) [hereinafter 9/11 SUMMARY].

3. *Id*.

4. *See id*.

5. *See id*. at 2–3.

changed world—a world with yellow, orange, and red security alerts,[6] less information, and fewer freedoms. While many changes have been made to address the vulnerabilities of the United States, many challenges remain. One that has contributed to much debate, even prior to 2001, is how to protect the thousands of chemical facilities that pose a threat due to the possibility of the hazardous chemicals they produce or store being released.

This Comment will discuss ways to encourage chemical manufacturing and storage facilities to embrace inherently safer technologies. These technologies, based on what is called "green chemistry,"[7] are necessary to eliminate the risk associated with hazardous chemical production, transportation, storage, and use.

As an alternative to using the traditional regulatory approach to implement the use of new technology, economic incentives could be used to encourage the switch to inherently safer technology.[8] Due to the complex nature of the chemical industry, a single program will not likely be successful.[9] This Comment suggests several incentives to encourage implementation of inherently safer technology, including strengthening the Chemical Weapons Convention (CWC), new tax policies, and limited liability for users of inherently safer technology.

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6. *See* DEP'T OF HOMELAND SEC., CITIZEN GUIDANCE ON THE HOMELAND SECURITY ADVISORY SYSTEM, http://www.dhs.gov/interweb/assetlibrary/CitizenGuidanceHSAS2.pdf (last visited Oct. 22, 2005) (on file with Author). The Department of Homeland Security created the Homeland Security Advisory System consisting of color coded alert levels corresponding to low, guarded, elevated, high, or severe to inform the public of the types of precautions to be taken. *Id.*

7. *See* Martyn Poliakoff et al., *Green Chemistry: Science and Politics of Change*, SCIENCE, Aug. 2, 2002, at 807. Green Chemistry is the use of intrinsic factors, or inherently safer technology, to reduce the hazard of chemical manufacturing. *See id*.

8. *See generally* Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law: The Democratic Case for Economic Incentives*, 13 COLUM. J. ENVTL. L. 171 (1988) (arguing for the use of economic incentives instead of command and control regulation).

9. Neil Gunningham, *Environmental Management Systems and Community Participation: Rethinking Chemical Industry Regulation*, 16 UCLA J. ENVTL. L. & POL'Y 319, 326 (1997).

Part II of this Comment will give an overview of the chemical industry. In Part III, this Comment will examine the vulnerabilities of hazardous chemical facilities. Part IV will review the existing regulatory landscape in the United States and discuss proposed legislation following September 11, 2001. Part V will introduce inherently safer technology, and Part VI will propose methods to encourage the proliferation of inherently safer technology.

II. CHEMISTRY IS BIG BUSINESS

The chemical industry is big business, both in the United States and the European Union (EU).[10] In the United States, the chemical industry is a $450 billion business, one of the largest sectors in the economy.[11] The more than 66,000 chemical facilities[12] across the nation employ more than one million workers.[13] Over five million jobs in the United States are related to the chemical industry, which impacts the health care, agricultural, construction, and automotive industries.[14]

The European chemical industry is a global force, controlling 28 percent of global output.[15] Employing some 1.7 million people, it is one of the top industries in most EU member states.[16] In the EU, three million jobs are dependent on it.[17] Worldwide, the chemical industry produces four hundred million tons worth € 1,244 billion (approximately $1.6 trillion).[18] Because of the sheer size of the chemical industry, a vulnerable chemical

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10. *Id.* at 321 & n.4.

11. AM. CHEMISTRY COUNCIL, PROTECTING A NATION: HOMELAND DEFENSE AND THE BUSINESS OF CHEMISTRY 1 (2002), http://www.accnewsmedia.com/docs/300/251.pdf.

12. HOUSE SELECT COMM. ON HOMELAND SEC., AMERICA AT RISK: THE STATE OF HOMELAND SECURITY-INITIAL FINDINGS 10 (2004).

13. AM. CHEMISTRY COUNCIL, *supra* note 11, at 1.

14. *Id.*

15. EUROPEAN CHEM. INDUS. COUNCIL (CEFIC), REACH: APPROACH OF THE EUROPEAN CHEMICAL INDUSTRY TO AN EFFECTIVE NEW CHEMICALS POLICY FOR EUROPE 2 (2004), http://www.cefic.be/files/Publications/Brochure REACH Cefic ANGL.pdf.

16. *Id.*

17. *Commission White Paper on Strategy for a Future Chemicals Policy*, at 4, COM (2001) 88 final (Feb. 27, 2001), *available at* http://europa.eu.int/eurlex/en/com/wpr/2001/com2001_0088en01.pdf.

18. *Id.*

facility could be a terrorist target that could lead to disruption to one of the engines of world economy.[19]

The complexity of the chemical industry will make a generic, one-size-fits-all regulation inappropriate.[20] The differences among chemical producers and the varied and intricate processes they incorporate contribute to this complexity.[21] Thus, because the modifications necessary to implement inherently safer technology present many complications, prescriptive regulation will not work for both large and small corporations.[22]

While the chemical industry has significantly reduced emissions, it remains a major source of pollution.[23] The industry is also a leading producer of toxic products and a contributor to ozone layer depletion.[24] The threat of damage to the environment by accident or explosion also exists at chemical facilities.[25] An accidental release of chemicals could result in serious damage to the local community, the environment, and even the national and global economy.[26]

III. THE VULNERABILITY IS REAL AND CREDITABLE

The United States has acknowledged that terrorists may be targeting soft targets[27] such as chemical plants.[28] The Department of Homeland Security has issued warnings of potential attacks on chemical facilities.[29] In addition, after

19. *See* Margaret Kriz, *Security Leak*, NAT'L J., Aug. 2, 2003, at 2477-78.

20. Gunningham, *supra* note 9, at 326.

21. *Id*. at 324–26 (describing the differences among chemical producers, including the large transnational company, the specialty chemical manufacturer, and the distributor, supplier, and buyer of wholesale chemicals).

22. *Id*. at 326.

23. *Id*. at 321.

24. *Id*. at 321–22.

25. *Id*. at 322.

26. *See id*.

27. Soft targets have little or no protection against enemy attack. *See* C.J.M. DRAKE ET AL., TERRORISTS' TARGET SELECTION 8 (1998).

28. Press Release, U.S. Dep't of Homeland Sec., Statement by the Department of Homeland Security on Continued Al-Qaeda Threats (Nov. 21, 2003), *available at* http://www.dhs.gov/dhspublic/display?content=3017.

29. *Id*.

reviewing trends in terrorism, the Department of Justice[30] concluded "the risk of terrorists attempting in the foreseeable future to cause an industrial chemical release is both real and credible."[31]

Terrorists may attack chemical facilities in two different methods: direct attacks on the facility or through efforts to gain access to hazardous chemicals.[32] A direct attack on a chemical production or storage facility may utilize conventional and unconventional weapons to cause a release.[33] Indirect attacks are used to gain access to chemicals to use as a weapon or to make weapons.[34] This Comment will focus on the vulnerabilities of direct attacks. However, the proposed solutions will also reduce the vulnerabilities of indirect attacks.

A. *Terror Attacks on Chemical Facilities Are Rare*

There is little evidence of prior terrorist incidents[35] involving chemical facilities.[36] Most of the prior attempts occurred in war zones, for example, in Croatia during the 1990s.[37] In the United

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30. While there is no universal definition of terrorism, the Federal Bureau of Investigation defines terrorism as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." 28 CFR § 0.85 (2005).

31. DEP'T OF JUSTICE, ASSESSMENT OF THE INCREASED RISK OF TERRORIST OR OTHER CRIMINAL ACTIVITY ASSOCIATED WITH POSTING OFF-SITE CONSEQUENCE ANALYSIS INFORMATION ON THE INTERNET 2 (2000), http://www.mipt.org/pdf/dojassessinternetctinfo.pdf. [hereinafter ASSESSMENT]

32. LINDA-JO SCHIEROW, CONGRESS RESEARCH SERVICE, REPORT FOR CONGRESS: CHEMICAL PLANT SECURITY 2 (2003), *available at* http://www.ncseonline.org/nle/crsreports/03Feb/RL31530.pdf.

33. *Id*. (discussing various weapons that may be used in a direct attack on a chemical facility, "including explosives, incendiary devices, firearms, airplanes, computer programs, or weapons of mass destruction . . . .").

34. *See id*.

35. The Federal Bureau of Investigation defines terrorist incident as "a violent act or an act dangerous to human life, in violation of the criminal laws of the United States, or of any state, to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." U.S. DEP'T OF JUSTICE, FED. BUREAU OF INVESTIGATION, TERRORISM IN THE UNITED STATES: 1999 ii (2000), *available at* http://www.fbi.gov/publications/terror/terror99.pdf [hereinafter TERRORISM IN THE U.S.].

36. SCHIEROW, *supra* note 32, at 5.

37. *Id*. at 4 (discussing attacks on chemical plants using hazardous chemicals such

States, while not successful, there have been reported attempts to cause releases from facilities.[38]

While direct attacks on chemical facilities have been rare, "[t]he ubiquitousness of industrial facilities possessing toxic chemicals and their proximity to population centers also make them attractive targets."[39] In fact, evidence of al Qaeda terrorist interest in targeting chemical facilities can be inferred from documents found in suspected al Qaeda hideouts.[40]

Although terrorist attacks on chemical facilities have been rare, terrorist attempts to use a chemical facility as a weapon of mass destruction should not be swept aside as unlikely. Risk is the likelihood of the event happening multiplied by the potential severity of the event's harm.[41] When the potential impact of an attack on a chemical facility is high, the risk will remain elevated, and a coordinated effort to minimize or eliminate the harm must be taken.

B. The Big Bang

> "If they're looking for the big bang, obviously you don't have to go far in your imagination to think about what the possibilities are." – Fred Webber, President of the American Chemical Association.[42]

There have been several "dramatic and highly publicized

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as ammonia and chlorine, and chemical plants producing fertilizer or pesticide, all of which are near population centers).

38. ASSESSMENT, *supra* note 31. In 1997, four people were arrested on conspiracy charges in a plot to blow up a refinery. *Id.* at 24–25. In 1999, two antigovernment militia members were arrested by the Federal Bureau of Investigation on conspiracy charges in an alleged plot to blow up a 24 million gallon propane storage facility. Sam Stanton & Gary Delsohn, *Pair Arrested in Alleged Terror Plot: Sources Say Elk Grove Propane Facility Targeted*, SACRAMENTO BEE, Dec. 4, 1999, at A9.

39. James Grimaldi & Guy Gugliotta, *Chemical Plants Feared as Targets*, WASH. POST, Dec. 16, 2001, at A1.

40. *Id*. (inferring al Qadea interest in attacks on chemical facilities based on U.S. chemical trade publications discovered in one of Osama bin Laden's hideouts).

41. Poliakoff et al., *supra* note 7, at 807.

42. Eric Pianin, *Toxic Chemicals Security Worries Officials; Widespread Use of Industrial Materials Makes Them Potential Targets of Terrorists*, WASH. POST, Nov. 12, 2001, at A14.

chemical accidents"[43] that can be used to estimate the potential harm of an accidental release of hazardous chemicals. Combining the consequences of these accidents with other estimates, such as worst-case release scenarios, illustrates the threat.

This Part will first discuss some of the imaginative ways a terrorist might attack a chemical facility, followed by a discussion of the chemical accidents, worst case scenarios, and other reports illustrating the potential enormity of a successful attack on a vulnerable chemical facility.

1. A Lack of Imagination

> "The most important failure was one of imagination. We do not believe leaders understood the gravity of the threat."[44]

The 9/11 Commission criticized the U.S. Government for its failure of imagination to foresee the attacks on the World Trade Center and the Pentagon.[45] While the impact of such an attack may be well known, the methods that could be employed to carry out an attack on a chemical facility are limited only by a terrorist's imagination.

One can pick up any magazine or search the Internet and find numerous examples of how the recently upgraded security at chemical plants could easily be compromised.[46] In one suggested scenario, terrorists utilize Soviet-era antiship mines

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43. Gunningham, *supra* note 9, at 322.

44. 9/11 SUMMARY, *supra* note 2, at 9.

45. *See* NAT'L COMM. ON TERRORIST ATTACKS UPON THE UNITED STATES, THE 9/11 COMMISSION REPORT: FINAL REPORT OF THE NATIONAL COMMISSION ON TERRORIST ATTACKS UPON THE UNITED STATES 339 (2004).

46. *See, e.g.*, S.C. Gwynne, *Attack Here*, TEX. MONTHLY, Nov. 2004, at 160; Joshua Sinai, *How to Forecast Intentions, Capabilities, and Likelihood of Terrorist Groups Resorting to Low Impact or Catastrophic Warfare*, J. OF COUNTERTERRORISM & HOMELAND SEC. INT'L 20 (2003); Christopher Helman & Chana R. Schoenberger, *Stopping the Bad Guys,* FORBES, Jan. 31, 2003, at 842; Kathleen McFall, *Nationwide Chemical Sites Are Targets of Opportunity*, ENG'G NEWS-RECORD, Dec. 1, 2003, at 6; SITTING DUCKS: THE THREAT TO THE CHEMICAL AND REFINERY INDUSTRY FROM 50 CALIBER SNIPER RIFLES, 2002, http://www.vpc.org/studies/duckcont.htm [hereinafter SITTING DUCKS].

loaded in a shipping container.[47] The ship carrying the container is allowed to proceed into the Houston Ship Channel because U.S. Customs only inspects some ten percent of entering containers.[48] When the ship reaches a major refinery, a global positioning system detonator initiates the blast.[49] This blast sets off chain reaction explosions at nearby facilities, leveling area buildings and releasing highly flammable chemicals.[50]

Others caution against the potential terrorist use of a weapon that often stirs contentious debate: the gun.[51] Using a fifty-caliber sniper rifle, a terrorist would be able to strike from a distance.[52] The capability of the fifty-caliber sniper rifle can easily circumvent traditional security measures such as guns, guards, and fences.[53] With an accuracy of up to two thousand meters and the power to shoot down a helicopter, a terrorist could release toxic chemicals by attacking hazardous storage facilities from relative seclusion.[54]

With increasing frequency, terrorists have attempted to gain access to weapons of mass destruction.[55] Treaties such as the CWC and other regulations make access to such weapons difficult. Terrorists may thus be forced to look to the release of toxic chemicals to achieve their goal of massive damage to property and life.[56] While chemical weapons are considered the least lethal of the weapons of mass destruction, a release of toxic

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47. Gwynne, *supra* note 46, at 160.

48. *Id*.

49. *Id*.

50. *Id*.

51. SITTING DUCKS, *supra* note 46 (suggesting the use of sniper rifles to attack storage tanks).

52. *See id*. The U.S. Army classifies fifty-caliber sniper rifles as "anti-materiel weapons, designed to attack bulk fuel tanks" from a distance. *Id*. While rockets and other weapons of war are highly regulated, fifty-caliber sniper rifles, which can be used against the same targets as rockets and mortars, are regulated commensurate to a traditional hunting rifle. *Id*.

53. *Id*.

54. *See id*.

55. *See* TERRORISM IN THE U.S., *supra* note 35, at 25; ASSESSMENT, *supra* note 32, at 2.

56. *See* ASSESSMENT, *supra* note 31, at 2.

chemicals from a chemical production or storage facility could be catastrophic.[57]

2. *The Impact Could Be Catastrophic*

> "Put in the right place, bombs can deliver the equivalent destructive power of a weapon of mass destruction."[58]

A 1998 report estimated that 41 million Americans live in "vulnerable zones" or geographic areas that could be seriously affected by the worst possible accident at a chemical production or storage facility.[59] Further evaluation of risk management plans add to the concern over vulnerable zones.[60] Many commonly used toxic chemicals have vulnerable zones extending up to 25 miles from the facility.[61]

The Environmental Protection Agency (EPA) reports that 123 chemical facilities have worst-case accidental release scenarios, which could expose more than one million people to a cloud of toxic gas.[62] The number grows to seven hundred facilities that could each expose at least one hundred thousand people and approximately three thousand facilities that could

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57. MICHAEL O'HANLON ET AL., PROTECTING THE AMERICAN HOMELAND: A PRELIMINARY ANALYSIS 47 (2002). A successful attack on a chemical plant could result in ten thousand fatalities compared to the one hundred thousand to one million possible fatalities from a nuclear bomb or biological attack, respectively. *Id*. at 6.

58. *See* Grimaldi & Gugliotta, *supra* note 39, at A30.

59. ALLISON LAPLANTE, TOO CLOSE TO HOME: CHEMICAL ACCIDENT RISKS IN THE UNITED STATES 1 (1998), *available at* http://uspirg.org/reports/tooclosetohome98.pdf.

60. *See* JAMES C. BELKE, CHEMICAL ACCIDENT RISKS IN U.S. INDUSTRY—A PRELIMINARY ANALYSIS OF ACCIDENT RISK DATA FROM U.S. HAZARDOUS CHEMICAL FACILITIES § 7.1.1 (2000), http://www.epa.gov/swercepp/pubs/stockholmpaper.pdf.

61. *Id*. at 26 (discussing the vulnerable zones, or radius of potentially affected population, for many commonly used toxic chemicals). Chlorine used in 90 ton rail cars is one of the most prevalent industrial chemicals and has vulnerable zones extending 14 miles in urban settings and 25 miles in rural settings. *Id.* Other toxic chemicals with similar vulnerable zones include: ammonia, hydrogen fluoride, sulfur dioxide, sulfur trioxide, chlorine dioxide, hydrogen chloride, hydrocyanic acid, and phosgene. *Id.*

62. U.S. GEN. ACCOUNTING OFFICE, HOMELAND SECURITY: VOLUNTARY INITIATIVES ARE UNDER WAY AT CHEMICAL FACILITIES, BUT THE EXTENT OF SECURITY PREPAREDNESS IS UNKNOWN, GAO-03-439, at 4 (2003), http://www.gao.gov/cgi-bin/getrpt?GAO-03-439 [hereinafter GAO].

each threaten at least ten thousand people.[63]

U.S. Army estimates are even more alarming. In a now classified report, the Army Office of the Surgeon General estimated that damage as a result of a toxic chemical release could be staggering.[64] Based on generic estimates, the Surgeon General put casualties upwards of 2.4 million.[65] If a release of chemicals of this magnitude were to occur, the impact on the national psyche, not to mention economy, would be cataclysmic.

While there have been no successful attacks on a chemical facility, several accidental chemical releases can be used to estimate the potential impact of a chemical facility attack.[66] Incidents at Texas City,[67] Seveso,[68] and Bhopal[69] caused massive damage, death, and destruction. While these industrial accidents changed the regulatory landscape both in the United

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63. *Id*.

64. *See id*. at 11.

65. *Id*.

66. *See id*. at 4; SCHIEROW, *supra* note 32, at 4.

67. In 1947, a fire aboard a French ship, the *Grandcamp*, triggered a series of explosions resulting in 4,100 killed or injured, approximately one quarter of the town's population. HUGH W. STEPHENS, THE TEXAS CITY DISASTER 1947 1, 102 (1997). The ammonium nitrate explosions caused damage to ninety percent of all homes in the town and left some two thousand homeless. *Id*. at 1, 6, 101–02. The Texas City dock was completely destroyed, along with the Monsanto Chemical plant and adjacent refineries. *Id*. at 4–6, 38–39. Property loses reached one hundred million dollars (approximately $1.1 billion today). *Id*. at 5.

68. In 1976, an explosion at the Industrie Chimiche Meda Societa Azionaria chemical plant near Seveso, Italy released tetrachlorobenzene, sodium hydroxide, and 2,4,5 trichlorophenol—an herbicide—into the air. *See* THOMAS WHITESIDE, THE PENDULUM AND THE TOXIC CLOUD: THE COURSE OF DIOXIN CONTAMINATION 31–32 (1979). It is estimated that some 37,000 people were exposed to the chemicals and eighty thousand farm animals were killed to prevent contamination of the food chain. Mark Corliss, *Dioxin: Seveso Disaster Testament to Effects of Dioxin*, JAPAN TIMES ONLINE, May 6, 1999, *available at* http://www.japantimes.co.jp/cgi-bin/getarticle.pl5?nn19990506a4.htm. The area contaminated was abandoned with the reclamation process taking years. *Id.*

69. Bhopal is considered one of the worst industrial accidents in modern times. JAMES KENNETH MITCHELL, THE LONG ROAD TO RECOVERY: COMMUNITY RESPONSES TO INDUSTRIAL DISASTER 141 (1996). Sometime during the night of December 2, 1984, 45 tons of methyl isocyanate gas was released, killing some 3,500 and injuring another three hundred thousand people. *Id*. at 121–22. Union Carbide Corporation paid $470 million in 1989 to settle claims. *Id*. at 132.

States and Europe, they also illustrate the potential of death and destruction that can occur.[70]

IV. EXISTING REGULATIONS DO NOT ENCOURAGE INHERENTLY SAFER TECHNOLOGY

Currently there are two main federal laws that attempt to reduce the risk associated with accidental release of hazardous chemicals.[71] The Clean Air Act and the Emergency Response and Community Right to Know Act will be briefly discussed, followed by an overview of voluntary efforts by industry to improve the safety of chemical facilities.

A. *Clean Air Act*

Congress has attempted to protect people from exposure to toxic or hazardous chemicals through many legislative acts.[72] Congress delegated to the EPA the task of promulgating standards for two leading pieces of legislation, the Clean Air Act (CAA) and the Clean Water Act (CWA).[73] For security of chemical facilities, the main source of power for the EPA is the CAA.[74] Specifically, § 7412(r) of the CAA requires the owners and operators of chemical facilities to implement a risk management plan (RMP).[75] The RMP mandate is required for

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70. The tragedy in Bhopal inspired the provisions of the 1990 Clean Air Act requiring plants to prevent accidental releases of toxic chemicals. *See* HOWARD E. HESKETH ET AL., EMISSION CONTROL FROM INDUSTRIAL BOILERS 9 (1995); WILLIAM R. MANGUN & DANIEL H. HENNING, MANAGING THE ENVIRONMENTAL CRISIS 233 (1999). The European Committee issued Directive 82/501, known as Seveso I, in response to the accident at Seveso. *See* Damian Chalmers, *Inhabitants in the Field of European Committee Environmental Law*, 5 COLUM. J. EUR. L. 39, 47 (1999). Regulations similar to the 1990 Clear Air Act inspired by Bhopal were adopted by the European Community. *See* Council Directive 82/501, art. 1–12, 18, 1982 O.J. (L230) 1 (EEC).

71. SCHIEROW, *supra* note 32, at 13.

72. Andrew Hanan, *Pushing the Environment Regulatory Focus a Step Back: Controlling the Introduction of New Chemicals Under the Toxic Substances Control Act*, 18 AM. J.L. & MED. 395, 398–99 (1992).

73. *Id.*

74. *See* GAO, *supra* note 62, at 4-5.

75. 42 U.S.C. § 7412(r)(1) (2005) (requiring owners and operators of chemical facilities to identify hazards, take steps to prevent releases, and minimize the effects of any accidental releases).

certain extremely hazardous chemicals stored or produced over certain prescribed amounts.[76]

The CAA also requires that certain facilities conduct Process Safety Management (PSM) hazard reviews.[77] The PSM hazard review is implemented by the Occupational, Safety, and Health Administration (OSHA) and requires the facility to address chemical hazards in the workplace to protect the workers.[78] PSM hazard reviews are very lengthy, technical reviews of every step of a process involving a regulated chemical.[79]

B. Emergency Response and Community Right to Know

In conjunction with the RMP requirements of the CAA, potential hazards of chemical facilities must be communicated under the Emergency Planning and Community Right to Know Act (EPCRA).[80] Under the EPCRA, state and local emergency response commissions must be established to coordinate planning and response to releases of hazardous chemicals.[81] Initially, this information was available to the public.[82] However, information contained in the RMP reports has been removed from the Internet[83] due to concerns of terrorists potentially using the information to plan attacks.

While the CAA provides the EPA with power to regulate the chemical industry in regard to accidental release of toxic

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76. *Id.* § 7412(r)(3) (requiring the administrator to develop a list of at least one hundred of the most dangerous substances which require PSM hazard review). The CAA requires the initial list to include toxic chemicals such as chlorine, anhydrous ammonia, methyl chloride, ethylene oxide, vinyl chloride, methyl isocyanate, hydrogen cyanide, ammonia, hydrogen sulfide, toluene diisocyanate, phosgene, bromine, anhydrous hydrogen chloride, hydrogen fluoride, anhydrous sulfur dioxide, and sulfur trioxide. *Id.*

77. 29 U.S.C. § 655 (2005).

78. *Id.*

79. 29 C.F.R. § 1910.119 (2005). The PSM standard applies to facilities that contain toxic and highly hazardous chemicals or store more than ten thousand pounds of flammable materials, with a few exceptions. *Id*.

80. *See* 42 U.S.C. § 11002.

81. *See id*. §§ 11001–11002.

82. Chemical Safety Information, Site Security and Fuels Regulatory Relief Act, Pub. L. No. 106-40, § 113 Stat. 207–11 (1999) (amending the CAA to limit access to RMP report information).

83. *Id*. (amending the CAA to limit access specifically with regard to dissemination of information on the Internet).

chemicals, the Department of Homeland Security has been given responsibility for chemical plant security.[84] Under Presidential Directive Seven, the Department of Homeland Security is required to "identify, prioritize, and coordinate the protection of critical infrastructure and key resources with an emphasis on critical infrastructure and key resources that could be exploited to cause catastrophic health effects or mass casualties comparable to those from use of a weapon of mass destruction."[85] The Directive also requires all departments and agencies to cooperate with the Department of Homeland Security Secretary.[86]

C. *Voluntary Efforts by Industry Fall Short*

The chemical industry has implemented many voluntary programs.[87] The American Chemistry Council (ACC), the Synthetic Organic Manufacturers Association, and the Chlorine Institute have cosponsored a publication to assist chemical facility managers in assessing the security risk of fixed facilities.[88] The ACC has long promoted a culture of safety through its program Responsible Care.[89] In response to the terrorist attack of September 11, 2001, the ACC expanded its Responsible Care program by collaborating with the Federal Bureau of Investigation's Hazardous Materials Response Team to optimize cooperation and informed communications.[90] ACC members:

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84. Homeland Security Presidential Directive Seven on Critical Infrastructure Identification, Prioritization, and Protection, 39 WEEKLY COMP. PRES. DOC. 1818, ¶ 15 (Dec. 17, 2003), *available at* http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2003_presidential_documents&docid=pd22de03_txt-19.pdf.

85. *Id.* ¶ 13.

86. *Id.* ¶ 19.

87. GAO, *supra* note 62, at 27–28.

88. AM. CHEMISTRY COUNCIL ET AL., SITE SECURITY GUIDELINES FOR THE CHEMICAL INDUSTRY 1 (Oct. 2001), http://www.accnewsmedia.com/docs/100/89.pdf [hereinafter SITE SECURITY GUIDELINES].

89. AM. CHEMISTRY COUNCIL, *supra* note 11, at 6. Responsible Care is a program in which every ACC member company must participate. *Id*. at 7. In its brief 14 years of existence, the program has reduced emissions and improved safety performance, while improving production. *Id*. at 7.

90. *See id*.

- Must prioritize safety hazards;[91]
- Must conduct security vulnerability assessments;[92]
- Must implement specific steps to enhance security based on the assessment;[93] and
- Should utilize third parties to verify its assessment.[94]

Efforts by the chemical industry are a good start to address the vulnerability concerns of chemical facilities. However, a coordinated effort must be undertaken to ensure that all high risk chemical facilities address security concerns. A Government Accounting Office (GAO) report concludes that the "federal government has not comprehensively assessed the chemical industry's vulnerabilities to terrorist attacks."[95]

The GAO points out that the voluntary programs developed by industry groups, such as the ACC, only cover a portion of the entire industry.[96] The EPA agrees that only a portion of the 15,000 RMP facilities would be covered by the ACC program.[97] In fact, ACC members own or operate only one thousand of the 15,000 RMP facilities, or only about seven percent.[98] While the chemical industry has made great strides to improve security, the combination of voluntary assessments and lack of government oversight leaves the level of preparedness unknown.[99]

Further, the voluntary industry action does not appear to be raising the level of preparedness.[100] Many reports show lax or

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91. *See id*. at 6.

92. SITE SECURITY GUIDELINES, *supra* note 88, at 5. Sandia National Laboratories plans to develop training materials and workshops on conducting security vulnerability risk assessment methodologies upon receipt of adequate funding, for which the ACC asks support. AM. CHEMISTRY COUNCIL, *supra* note 11, at 13.

93. *See* SITE SECURITY GUIDELINES, *supra* note 88, at 5–7.

94. *See id.* at 7–8.

95. GAO, *supra* note 63, at 4.

96. *See id.* at 5.

97. *Id.*

98. *Id.*

99. *See id.*

100. *See* Carl Prine, *Lax Security Exposes Lethal Chemical Supplies*, PITTSBURG TRIBUNE-REVIEW, April 7, 2002, *available at* http://www.pittsburghlive.com/x/tribune-review/specialreports/potentialfordisaster/s_64612.html.

even nonexistent physical security.[101] One of the most alarming reports was a series of Pittsburg Tribune-Review articles documenting the poor security at chemical facilities in western Pennsylvania, as well as in Houston, Chicago, and Baltimore.[102]

One of the more damning reports was commissioned by the National Institute of Health (NIH) and conducted by the Paper, Allied Industrial, and Chemical and Energy Workers Union (PACE). This report shows that in the three years since September 11, while three quarters of the chemical facilities had made site security improvements, some of the largest plants in the nation have not taken "steps to prevent or prepare for a release of toxins."[103]

There are no current regulations that require chemical facilities to protect themselves from terrorist attack.[104] While the EPA believes the CAA may be interpreted as requiring chemical facilities to prepare for a possible terrorist threat, it is unwilling to enforce these provisions.[105] The EPA is concerned that acting on such an interpretation would lead to significant litigation.[106] Consequently, the EPA recommends specific legislation be enacted to address chemical plant security.[107]

D. *Current Legislative Attempts Do Not Address the Problem*

1. *Chemical Security Act of 2003*

Senator Corzine of New Jersey introduced the Chemical Security Act of 2003 as an attempt to address the lack of

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101. *See*, *e.g.*, *id.*; Carl Prine, *Chemicals Pose Risk Nation Wide*, PITTSBURG TRIBUNE-REVIEW, May 5, 2002, *available at* http://www.pittsburghlive.com/x/tribune-review/specialreports/potentialfordisaster/s_69664.html [hereinafter Prine, *Chemicals Pose Risk Nation Wide*]; Carl Prine, *Study Finds Chemical Plants Are Still Vulnerable to Terrorism,* PITTSBURG TRIBUNE-REVIEW, October 28, 2004, *available at* http://www.pittsburghlive.com/x/tribune-review/trib/regional/s_266710.html [hereinafter Prine, *Study Finds Chemical Plants Are Still Vulnerable to Terrorism*].

102. *See* Prine, *Chemicals Pose Risk Nation Wide*, *supra* note 101.

103. *See* Prine, *Study Finds Chemical Plants Are Still Vulnerable to Terrorism*, *supra* note 101.

104. *See* GAO, *supra* note 62, at 12.

105. *Id.*

106. *Id.*

107. *Id.*

security at chemical facilities.[108] The Chemical Security Act of 2003 called on both the EPA and the Department of Homeland Security to address the challenge of protecting the chemical infrastructure in the United States.[109]

The Bill would give the EPA the lead role in the process; however, it would also require the EPA to work closely with the Department of Homeland Security.[110] The EPA along with the Department of Homeland Security and other state and local entities would identify high priority categories.[111] Those identified within a high priority category would be required to certify regulatory compliance within one year.[112]

One of the more contentious issues with the Chemical Security Act of 2003 was the requirement for the use of inherently safer technologies.[113] For a variety of reasons, including concerns with increased costs, industry groups have lobbied against passage of the Bill.[114]

2. *Proposed Chemical Facility Security Act of 2004*

Similar to the Chemical Security Act of 2003, the Chemical Facility Security Act of 2004 was introduced by Senator Inhofe to increase the security of chemical plants in the United States.[115] While similar to the proposed Chemical Security Act of 2003 in many aspects, the Chemical Facility Security Act of 2004 differs in two major aspects. First, the Chemical Facility Security Act of 2004 would authorize the Department of Homeland Security to oversee security assessments.[116] Second, it

108. *See* Chemical Security Act of 2003, S. 157, 108th Cong. (2003).

109. *See id*. § 4(a).

110. *See id.*

111. *Id.*

112. *Id.* § 4(b)(2).

113. *See* Jeff Johnson, *Simply Safer*, CHEM. & ENG'G. NEWS, Feb. 3, 2003, at 23.

114. *See id.*; GAO, *supra* note 62, at 28–29.

115. *See* Chemical Facilities Security Act of 2004, S. 994, 108th Cong. (2004).

116. *Compare id.* § 3(a)(1) (requiring the Secretary of the Department of Homeland Security to promulgate regulations for vulnerability assessments of chemical facilities) *with* Chemical Facilities Security Act of 2003 § 4(a) (requiring Administrator of the EPA to promulgate regulations in a similar manner).

would not require the inherently safer technology assessment.[117]

3. Proposed Legislation Falls Short

The current trend in legislation is to add layers to minimize the risk of operating a chemical facility.[118] These added safety layers will help by reducing the risk of unauthorized chemical access, but they will not eliminate the overall operating risk.[119] As long as there are large inventories of toxic chemicals, terrorists will have an interest in causing their release.[120] By not addressing inherently safer technology, current legislation leaves the Nation's chemical facilities vulnerable to attacks resulting in catastrophic chemical release.[121]

No current federal law mandates the use of inherently safer technology.[122] Neither Senate bill 157 proposed by Senator

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117. *Compare* Chemical Security Act of 2003, S. 157, 108th Cong. (2003) §§ 2-4 (defining the term and referring to incorporation of inherently safer technology and safer design in assessment plans) *with* Chemical Facilities Security Act of 2004, S. 994, 108th Cong. (2004) (leaving out the inherently safer technology assessment but mandating "consideration" as an assessment requirement, which included, *inter alia*, "an analysis of alternative approaches" and "the cost and technical feasibility of alternative approaches" to "prevent or reduce the threat or consequences of a terrorist release").

118. *Compare* Dennis C. Hendershot, *Safety Through Design in the Chemical Process Industry: Inherently Safer Process Design*, (1999) http://home.att.net/~d.c.hendershot/papers/pdfs/nsc897.pdf (contrasting increased effort within the chemical process industry to employ inherently safer chemical processes with traditional approach of adding layers to minimize risk), *with* Chemical Facilities Security Act of 2003 § 4(b) (including inherently safer technology as a "safer design" requirement that "high priority" chemical facilities must address in a required prevention, preparedness, and response plan).

119. *See* Hendershot, *supra* note 118, at 3.

120. *Cf.* PETER J. VAN KRIEKEN, TERRORISM AND THE INTERNATIONAL LEGAL ORDER 201 (2002) (noting that deadly chemicals are of the most interest to terrorists intending to kill large numbers of people).

121. *See generally* Nicholas Askoounes Ashford & Gerard Zwetsloot, *Encouraging Inherently Safer Production in European Firms: A Report from the Field*, J. HAZARDOUS MATERIALS 123 (1999) (contending that without the combination of inherently safer technology, secondary prevention, and mitigation, facilities cannot eliminate the possibility of catastrophic chemical accidents).

122. *See Chemical Security Act: Hearing on S. 1602 Before the Subcomm. on Superfund, Toxics, Risk, and Waste Mgmt. of the Senate Comm. on Env't and Pub. Works*, 107th Cong. 22 (2001) (statement of Paul Orum, Director, Working Group On Community Right-to-Know) (stating that no federal law addresses the risks of communities living around hazardous chemical industries).

Corzine nor Senate bill 994 proposed by Senator Inhofe have passed the Senate.[123] One of the many reasons Senate bill 157 was not passed may have been a lack of understanding of inherently safer technology.[124] Thus, this Comment will review inherently safer technology before discussing how it might be encouraged.

V. INHERENTLY SAFER TECHNOLOGY CAN IMPROVE CHEMICAL FACILITY SECURITY

Trevor Kletz, in reaction to the explosion at Flixborough in 1974,[125] coined the term "inherently safer design," which is a philosophy to eliminate or minimize hazards rather than to control the hazard.[126] The concepts of inherent safety are not new, but rather, they have been known for some one hundred years.[127] While the traditional approach has been successful in controlling the hazard, the traditional layers of protection may not deter a terrorist attempting to cause a release of a hazardous chemical.[128]

A. What Is Inherently Safer Technology?

> "This is all that I have learnt: God made us plain and simple, but we have made ourselves very complicated."
> – Ecclesiastes 7:29

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123. *See* Norman W. Spindal & Priya Masilamani, *Chemical Plant Security: New Programs Under Consideration; Proposed Laws Would Have Significant Impact on Businesses that Use Dangerous Chemicals*, 178 N.J.L.J 948, 2 (2004).

124. *See* T.A. Kletz, *Inherently Safer Design-Its Scope and Future*, 81 TRANSACTIONS OF THE INST. OF CHEM. ENG'RS 401, 404 (2003) [hereinafter Kletz, *Scope and Future*].

125. TREVOR KLETZ, PLANT DESIGN FOR SAFETY: A USER-FRIENDLY APPROACH 11–12, 28–32 (1991) [hereinafter KLETZ, PLANT DESIGN FOR SAFETY] (describing the explosion at a Flixborough, U.K facility killing 28 people as a result of a leak of cyclohexanone due to the failure of a bellow).

126. Trevor Kletz, *Safer by Design,* CHEMBYTES EZINE (Jan. 1999) http://www.chemsoc.org/chembytes/ezine/1999/kletz.htm [hereinafter Kletz, *Safer by Design*].

127. TEX. A&M UNIV. MARY KAY O'CONNOR PROCESS SAFETY CENTER, CHALLENGES IN IMPLEMENTING INHERENT SAFETY PRINCIPLES 2 (2002), http://psc.tamu.edu/publications/WhitePaper_InherentSafety1.pdf.

128. *See id.*; HENDERSHOT, *supra* note 118, at 3 (arguing that despite layers of protection, underlying hazards of chemical processes still exist).

The *American Heritage Dictionary of English Language* defines "inherent" as, "[e]xisting as an essential constituent or characteristic; intrinsic,"[129] and "safe" as "[s]ecure from danger, harm, or evil."[130] Thus, inherently safer technology is chemical production that has safety features innate to the process rather than added on.

Traditional safety procedures dealing with chemical processes typically rely on layers of protection between the hazard and the public.[131] This is usually achieved by using the process design, controls, alarms, safety interlock systems, mitigation systems, emergency response systems, and community response systems.[132] By adding these layers, or rings of protection, the hazard of the process is mitigated.

Inherently safer design differs from the traditional approach because the hazard is eliminated or reduced by changing the process rather than by adding layers of safety protection.[133] Inherently safer technology is accomplished through four basic strategies: minimization, substitution, moderation, and simplification.[134]

1. Intensification

> "In small proportions we just beauties see, And in short measures life may perfect be."— Ben Jonson (1573–1637)[135]

Minimization or intensification, the most widely used method,[136] is a very simple concept. Intensification involves the use of smaller quantities of hazardous substances.[137] By reducing

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129. AMERICAN HERITAGE DICTIONARY 901 (4th ed. 2000).

130. *Id.* at 1531.

131. *See* HENDERSHOT, *supra* note 118, at 3.

132. *Id.*

133. *Id.* at 5.

134. *Id.* at 7.

135. JOHN BARTLETT, FAMILIAR QUOTATIONS 233 (Justin Kaplan ed., Little, Brown and Co. 1992) (1855).

136. ROYAL SOC'Y OF CHEMISTRY, ENV'T, HEALTH, AND SAFETY COMM., INHERENTLY SAFER CHEMICAL PROCESSES 2 (2000), http://www.rsc.org/pdf/ehsc/inherently.pdf.

137. *Id.*

the hazardous or toxic substance, the risk of damage from release will be reduced.[138] Several areas exist where intensification can reduce hazards.[139] The two major areas are process type, or reaction, and storage.[140]

Chemical processes are classified into three categories: batch, semi-batch, or continuous.[141] One inherent quality of batch processes is a tendency to have larger process volumes than a continuous process producing equal quantities.[142] By utilizing continuous processes where feasible, the chemicals processed in the reactor can be minimized.[143]

Another area where intensification can lead to reduced risk is storage or inventory of intermediates, which are usually reactive chemicals.[144] Next to process type, no other unit operation offers greater opportunities for intensification than storage.[145] Some chemical plants will store large amounts of dangerous, intermediate chemicals for no reason other than convenience.[146] One striking example was Union Carbide's policy in the aftermath of Bhopal to immediately use methyl isocynate (MIC) when it was produced, rather than store it.[147] A Dupont plant reduced storage of MIC from forty thousand or fifty thousand pounds to only two pounds of MIC.[148]

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138. *See* KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 12.

139. *See id.* at 21–49 (describing the various unit operations where intensification can increase safety and reduce cost).

140. *Id.* at 21.

141. *See* RICHARD M. FELDER & RONALD W. ROUSSEAU, ELEMENTARY PRINCIPLES OF CHEMICAL PROCESSES 83–84 (2d ed. 1986). In a batch process, the chemicals (reactants) are charged to the reactor, and the product is removed all at once at a later time. *Id.* In continuous process, the reactants are fed, and the products are removed continuously. *Id.* A semi-batch is neither a batch nor a continuous process. *Id*. An example of a semi-batch process might entail the mixing of liquids in a reservoir without any withdrawal. *Id.*

142. *See* KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 21.

143. *See* HENDERSHOT, *supra* note 119, at 7. For example, a fifty liter loop reactor and a five thousand liter batch reactor have equivalent capacity. *Id.*

144. KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 45.

145. *Id.*

146. *See id.*

147. *Id.*

148. *See* SANFORD LEWIS, THE SAFE HOMETOWNS INITIATIVE, THE SAFE HOMETOWNS GUIDE: HOW TO DO A COMMUNITY REASSESSMENT OF CHEMICAL SITE

2. Substitution

"In this world second thoughts, it seems, are best."
– Euripides (485 – 406 B.C.)[149]

Substitution replaces the hazardous material with one that is less hazardous.[150] This is not a new practice; many consumer products have switched to safer substances.[151] One example is paint.[152] Over the year's paint formulations have evolved from use of solvent-based to water-based formulations.[153] Other examples included substitution of less hazardous chemicals for hazardous chemicals such as asbestos and benzene.[154]

Substitution is not limited to raw materials.[155] Alternative processes can also be substituted.[156] An example of how substitution in chemistry can have a profound impact is the process for production of carbaryl.[157] The Bhopal process reacted -naphthol and methylamine to from MIC.[158] MIC, an intermediate, was easy to store, but storage was not essential.[159] The "MIC was then reacted with -naphthol to make" the final product carbaryl.[160] By simply changing the order of the reaction, reacting -naphtol with phosgene, the highly toxic MIC would not be produced.[161]

SAFETY AND SECURITY AFTER SEPTEMBER 11, 2001 3–4, http://www.safehometowns.org/safehometowns.pdf.

149. BARTLETT, *supra* note 135, at 68.

150. KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 53.

151. *See id.*

152. ROYAL SOC'Y OF CHEMISTRY, *supra* note 136, at 3.

153. *Id.*

154. *Id*.

155. *See* Kletz, *Safer by Design*, *supra* note 126 (discussing the use of substitution for materials and chemical processes).

156. *See id*.

157. Carbaryl is an insecticide produced from -naphthol, methylamine, and phosgene. *Id.* This was the product produced at the Union Carbide facility in Bhopal, India. JOHN J.W. ROGERS & P. GEOFFREY FREISS, PEOPLE AND THE EARTH: BASIC ISSUES IN THE SUSTAINABILITY OF RESOURCES AND ENVIRONMENT 262 (1998).

158. *See Kletz, Safer by Design*, *supra* note 126.

159. *Id*.

160. *Id*.

161. *Id*. (reaction of -naphtol with phosgene will produce a chloroformate ester avoiding the hazards of the MIC).

One of the most publicized substitutions following 9/11, was implemented outside Washington, D.C., at the Blue Plains Wastewater Treatment Facility.[162] The Blue Plains facility, like most water and waste water treatment facilities, utilized chlorine gas to disinfect the water.[163] Following the attacks of 9/11, the facility switched from chlorine to sodium hypochlorite.[164] The switch to the safer sodium hypochlorite eliminated the use of 90 ton rail cars that could have put the 1.7 million people in the Washington, D.C. area at risk.[165]

3. Moderation

> "Never go to excess, but let moderation be your guide."
> – Cicero (106 B.C. – 43 B.C.)[166]

Moderation should be used if intensification and substitution are not viable alternatives.[167] Moderation reduces hazards by reducing conditions that lead to hazardous impacts.[168] Minimizing the impact is accomplished by dilution, a reduction in temperature, or a reduction in pressure.[169]

There are many examples of how moderation can reduce hazardous impacts.[170] One example is the storage of chlorine or ammonia. By storing ammonia and chlorine refrigerated at atmospheric pressure, the amount of chemical that would escape in the event of a leak will be much smaller then if the chlorine or ammonia was stored under pressure.[171]

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162. Grimaldi & Gugliotta, *supra* note 39, at A30.

163. *Id.*

164. *Id.*

165. *Id.*

166. DONALD K. SHARPES, ADVANCED EDUCATIONAL FOUNDATIONS FOR TEACHERS 90 (Routledge 2001).

167. M. Sam Mannan et al., *Fundamentals of Process Safety and Risk Management*, *in* 69 ENCYCLOPEDIA OF CHEMICAL PROCESSING AND DESIGN 80 (Rayford G. Anthony & John J. McKetta eds., 2001 & Supp. I 2002).

168. TEX. A&M UNIV., *supra* note 127, at 2.

169. *See* KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 68 (discussing "attenuation," a synonym for the moderation concept, as reducing risk through lower reaction temperature and lower operating pressure).

170. *See id*. at 67–71 (providing examples of attenuation's benefits in reducing risk).

171. Mannan, *supra* note 167, at 80.

4. Simplification

"Our life if frittered away by detail. Simplify, simplify."– Henry David Thoreau (1817–1862)[172]

Simpler processes are safer processes.[173] Elimination of unnecessary complexity can reduce the possibility of a release.[174] Fundamentally simpler processes are those with fewer reactions and process steps.[175]

Complexity comes from several sources including the need to mitigate the hazard, following specifications blindly, and the desire for flexibility.[176] When inherently safer techniques such as intensification and substitution are used, the need for additional safety measures is reduced or even eliminated.[177] Without the need for additional safety measures, the process becomes simpler.

Even if the plant is designed with simplification in mind, blindly following specifications, standards, and codes, will lead to complicated systems.[178] When following such regulations, one should ask why they were accepted.[179] Since no two situations will be identical, circumstances unforeseen by those writing the specifications, standards, or codes can lead to unnecessary expense and complication.[180]

One of the biggest sources of complexity is the desire for flexibility. Plant operators want flexibility to allow the plant to run in case of equipment malfunction.[181] For instance, operators may want spare pumps installed as backups when, in fact, uninstalled spare pumps are an equally effective but less complex option.[182] Similarly, consider the metaphorical

172. HENRY DAVID THOREAU, WALDEN AND CIVIL DISOBEDIENCE 135–36 (Penguin 1983).

173. *See* KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 83.

174. *See id*.

175. Hendershot, *supra* note 118, at 7.

176. KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 3, 103.

177. *Id*. at 3.

178. *See id*.

179. *Id.*

180. *Id.* at 104.

181. *See id*. at 108.

182. *Id*. at 107.

"spaghetti bowl" that would result if three parallel streams of three stages were configured so that each stage could be used in each stream.[183] This would require many additional valves and cross-over lines for each stage, resulting in unnecessary complexity, which could be curtailed simply by focusing instead on the reliability of the units so that a stage does not fail.[184]

B. Cost Benefits of Inherently Safer Technology

Inherently safer technology provides one apparent benefit, safety, and one benefit that may not seem obvious, cost savings.[185] The methods discussed above, intensification, substitution, moderation, and simplification, are all used to minimize or eliminate threats to safety aspects of utilization of hazardous chemicals. Many argue that a requirement of inherently safer technology will lead to more expensive treatment technology.[186] However, inherently safer technology usually leads to cheaper costs.[187]

The Chemical Producers and Distributors Association, in a White Paper against the Chemical Security Act of 2003, argue that inherently safer technology does not take into account the probable costs of making a switch to inherently safer technology.[188] It argues that inherent safety and security are separate concepts and that switching to inherently safer technology will introduce significant costs that should be used to harden sites because it is more effective.[189] The Association presents no data supporting its position; instead, it contends

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183. *See id.* at 108–09.

184. *Id*.

185. *See* J.P. Gupta et al., *The Real Cost of Process Safety-A Clear Case for Inherent Safety*, 81 TRANS ICHEME 406 (2003).

186. *See, e.g.*, Angela Logomasini, *Utopian Policymaking: The Inherent Dangers of "Inherently Safer Technology"*, NAT'L REV. ONLINE, May 5, 2003, http://www.nationalreview.com/comment/comment-logomasini050503.asp.

187. Kletz, *Scope and Future*, *supra* note 124, at 401. Inherently safer design will result in lower design and operating costs because less add-on equipment will be necessary. *Id.* at 401.

188. THE CHEM. PRODUCERS & DISTRIBS. ASSOC., REQUIRING "INHERENTLY SAFER TECHNOLOGY" WILL NOT MAKE AMERICA INHERENTLY MORE SECURE 1 (2003), http://www.cpda.com/TeamPublish/uploads/chemical_security_12.doc.

189. *See id*. at 1–2.

that inherent security will weaken the industry.[190]

By implementing inherently safer designs, the overall cost of a chemical facility can be significantly reduced.[191] It is estimated that one-third to one-half or more of chemical project costs are due to added safety features.[192] Elimination of hazards will also lead to fewer regulations covering the operations of the facility, reducing the operating costs of the facility.[193]

VI. ENCOURAGING INHERENTLY SAFER TECHNOLOGY

> "Change—Change—who wants change? Things are bad enough as they are." – Lord Salisbury, Prime Minister to Queen Victoria.[194]

Chemical safety has experienced many changes over the years.[195] Unfortunately, implementation of inherently safer technology has not occurred as quickly as other advances in process safety.[196] For example, the Hazop concept was introduced in 1974 and within ten years was extensively adopted.[197] Yet since its introduction in 1978, inherently safer technology has not grown as fast.[198]

There are several possible reasons why the use of inherently safer technology has not grown.[199] One of the main reasons is that inherently safer technology must be introduced earlier in the design process and may rely on the use of unconventional technology.[200] Because of the time necessary to evaluate new, unproven technology and the risks associated with it, company executives are often reluctant to gamble on new technology.[201]

190. *Id*. at 2.

191. Gupta et al., *supra* note 185, at 412.

192. *Id.*

193. *See id*.

194. NAT'L STAFF DEV. COUNCIL, POWERFUL WORDS, http://www.nsdc.org/library/words.cfm (quoting Lord Salisbury).

195. Kletz, *Scope and Future*, *supra* note 124, at 401.

196. *Id.* at 403.

197. *Id.*

198. *Id.*

199. *See id.*

200. *See id.*

201. *See id.*; *see also* T.A. Kletz, *The Constraints on Inherently Safer Design and*

Thus, the conservative nature of management stifles innovative solutions.[202]

Analogies to other studies also suggest barriers to implementing inherently safer technology.[203] These studies point to economic, behavioral, and organizational barriers.[204] The studies also suggest lack of tax incentives and poor accounting practices as contributing to the slow uptake of inherently safer technology.[205]

Europe has often been on the leading edge of environmental protection.[206] The EU has proposed fundamental reform of chemical legislation.[207] The core of the reforms is laid out in the *Commission White Paper on Strategy for a Future Chemicals Policy* (White Paper).[208] The White Paper describes the REACH system,[209] which attempts to ensure "a high level of protection of human health and the environment."[210] The policy is based on the precautionary principle[211] and has an objective to substitute less dangerous chemicals where suitable alternatives exist.[212]

Other Innovations, 18 PROCESS SAFETY PROGRESS 64 (1999).

202. KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 11 (quoting C.H. Kline, "The main obstacle to innovative problem solving . . . is over-conservatism in management . . . . Imaginative solutions to problems always run counter to the conventional wisdom of the firm.").

203. Poliakoff et al., *supra* note 7, at 808.

204. *See id.* (stating that barriers identified to the industrial innovation of energy efficiency also apply to green chemistry technology).

205. *Id.*

206. *See* Säbine Gärtner et al., *Chemical Safety in a Vulnerable World*, 42 ANGEWANDTE CHEMIE INT'L ED. 4456, 4468 (2003).

207. *Id*. at 4461.

208. Commission White Paper on Strategy for a Future Chemicals Policy, COM (2001) 88 final (Feb. 27, 2001).

209. *Id.* at 16 (describing the REACH system, consisting of three elements—registration, evaluation, and authorization—all of which would be applied to every new and existing chemical).

210. *Id.* at 5.

211. The precautionary principle embodies the idea that in the face of scientific uncertainty, if there exists scientific evidence indicating a matter may cause a potential adverse effect upon public health and the environment, decisions must be tempered to precaution against adverse effects. *Id*.

212. *Id.*

The REACH system has several goals: making industry responsible for safety, substitution of hazardous chemicals, and stimulating innovation are just a few.[213] The White Paper acknowledges that the success of the REACH system is based on efficient functioning and competitiveness of the chemical industry.[214] To achieve this, the program must incorporate "ecological, economic, and social aspects of development" through a comprehensive and balanced approach.[215]

The global nature of the chemical industry requires a global solution.[216] Such a solution should require local, national, and international cooperation to go beyond command and control regulation alone, with the end goal of developing economic incentives to encourage inherently safer technology.[217] There has been some progress in this area since the First Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992.[218] Several successful international efforts, such as the Montreal Protocol and the Prior Informed Consent (PIC) Convention, have been implemented to achieve improved chemical safety.[219] Because the chemical industry has a global market, intensification of international cooperation will be necessary to achieve meaningful results.[220] Strengthening the CWC, building upon the successes of the Montreal Protocol, and limiting liability for companies that implement inherently safer technologies are just three policies that can help inherently safer technologies flourish.

213. *Id.* at 7–9.

214. *Id.* at 5.

215. *Id.*

216. *See* Gärtner et al., *supra* note 206, at 4467–68.

217. Marco Eissen et al., *10 Years after Rio-Concepts on the Contribution of Chemistry to Sustainable Development*, 41 ANGEWANDTE CHEMIE INT'L ED. 414, 429 (2002).

218. *See* Gärtner et al., *supra* note 206, at 4464–67 (discussing the programs developed to implement the six key areas outlined under Chapter 19 of Agenda 21).

219. *Id*. at 4468 (discussing the Montreal Protocol, Persistent Organic Pollutants (POP) Convention, PIC Convention, and others).

220. *Id*. at 4468.

A. Strengthening the CWC

By strengthening the CWC, the cost of producing chemicals identified in the CWC will increase. The increased cost will provide a driving force to implement new, less hazardous chemicals and inherently safer technologies. Because the CWC has also made it more difficult for terrorist to obtain chemical weapons, strengthening the CWC and encouraging the use of inherently safer technologies will limit the facilities that terrorists may target.

1. History and Development of the CWC

The use of chemicals as weapons is not new. In fact, toxic fumes were reported in conflicts in India in 2000 B.C.[221] The chemical weapons used today are also not new. Phosgene and mustard gas, both considered modern chemical weapons, were developed in 1811 and 1854, respectively.[222] Even with this long history, the use of chemical weapons has been limited.[223]

Much of the limited use of chemical weapons by warring nations can be attributed to the views of the professional soldier who considered use of chemicals as "unworthy of a man of heart and a real soldier."[224] One of the first international treaties "banning chemical warfare was a Franco-German treaty" in 1675.[225] In 1874, fourteen European countries signed the Brussels Declaration on the laws and customs of war.[226] Even at that time, the use of chemical weapons was considered so taboo

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221. Michael L. Moodie, *The Chemical Weapons Threat*, *in* THE NEW TERROR: FACING THE THREAT OF BIOLOGICAL AND CHEMICAL WEAPONS 5 (Sidney D. Drell et al. eds., 1999).

222. *Id.* at 5–6.

223. *See generally* RICHARD M. PRICE, THE CHEMICAL WEAPONS TABOO (1997) (discussing the restraint in using chemical weapons in warfare throughout history).

224. Tony Freemantle, *The Price of Peace: A Long History*, HOUS. CHRON., Nov. 23, 1997, at Special 8.

225. Jonathan B. Tucker, *From Arms Race to Abolition: The Evolving Norm Against Biological and Chemical Warfare, in* THE NEW TERROR: FACING THE THREAT OF BIOLOGICAL AND CHEMICAL WEAPONS 162–63 (Sidney D. Drell et al. eds., 1999) [hereinafter Tucker, *From Arms Race*].

226. *Id*. at 163 (noting prohibition of the use of poison or poisonous gases as well as arms, projectiles, or materials that would cause unnecessary suffering).

that prohibition on the use of poison was not even debated.[227]

While treaties prohibiting the use of poison or poisonous weapons were ratified, they did not actually prevent the use of chemical weapons in World War I.[228] On April 22, 1915, German troops opened some six thousand cylinders releasing 168 metric tons of chlorine gas on the front lines at Ypres, Belgium.[229] The Germans continued with phosgene in 1915 and mustard gas in 1917.[230] The Allied forces retaliated with mustard gas.[231] It was estimated that by the end of the war 124,200 metric tons of chemical weapons caused some one million casualties, more than 90,000 of them fatalities.[232]

Although chemical weapons were employed during World War I, British use was limited to retaliation for attacks using chemicals, and among all warring states, avoiding noncombatants was the norm.[233] Delivery of chemical weapons, however, is no easy task.[234] Terrain and atmospheric conditions such as wind speed, humidity, precipitation, and exposure to sun make effectiveness difficult.[235]

The difficulties in using chemical weapons and the low death toll compared to conventional weapons in World War I did not discourage attempts to ban chemical weapon use.[236] The Treaty

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227. *Id*. at 163–64.

228. *See id*. at 164–65. Both Hague Conferences in 1899 and 1907 included bans on the use of poison or poisonous weapons. *See id*. The first Hague Convention prohibited the use of projectiles designed to diffuse asphyxiating or deleterious gases, and its article 23(a) reaffirmed the prohibition on the use of poison or poisonous weapons. *Id.* at 164. The second Hague Convention reaffirmed this ban. *Id*. at 165.

229. Tucker, *From Arms Race*, *supra* note 225, at 165.

230. *Id.* at 166.

231. *Id.*

232. *Id.*

233. *Id*. at 167.

234. Moodie, *supra* note 221, at 16.

235. *Id.* at 15–16.

236. *Compare* Tucker, *From Arms Race*, *supra* note 225, 166–67 (indicating total chemical warfare casualties and fatalities of approximately one million and 90,000, respectively) *with* Michael Duffy, *Feature Articles: Military Casualties of World War One*, FIRST WORLD WAR.COM, Jul. 12, 2003, http://www.firstworldwar.com/features/casualties.htm (indicating total casualties of World War I estimated at 31,508,200 with 7,996,888 fatalities). The death toll from chemical weapons was considered low. Tucker, *From Arms Race*, *supra* note 225, at 167.

of Versailles at the end of World War I included Article 171, which specifically prohibited the "use of asphyxiating or poisonous gases and liquids."[237]

Even with the general agreement on the ban of chemical weapons, the Geneva Protocol and other agreements did not end the use of chemical weapons.[238] In the period leading up to World War II, there were violations of the Geneva Protocol, and chemical weapons were used by parties that were not signatories to the Protocol.[239]

While the Geneva Protocol did have some impact on the use of chemical weapons, it did not stop the research, production, and stockpiling of them.[240] By the end of World War II various countries had produced an aggregate of over 390,000 tons (780 million pounds) of various chemical agents.[241] During the 1950s and 1960s, production of chemical weapons would continue.[242]

When concerns of actual use of chemical weapons started to surface in the early 1970s, negotiation began for an all-out ban on chemical weapons.[243] Talks for what would become the CWC continued for almost twenty years until the CWC was opened for signature in 1993.[244]

The CWC attempts to eliminate all chemical weapons, to verify the destruction of the chemical, and to verify that chemical production facilities producing dual-use chemicals,[245] or precursors to chemical weapons, do not misuse them.[246] The

237. Tucker, *From Arms Race*, *supra* note 225, at 167.

238. *Id.* at 170–72.

239. *Id*.

240. *Id*. at 170.

241. *See id*. at 178.

242. *Id*. at 178–80.

243. *Id*. at 188–89.

244. *Id.* at 189–200.

245. Dual-use chemicals are chemicals that can be utilized as a chemical weapon, but also have a significant commercial purpose. *See* Moodie, *supra* note 221, at 17. For example, thiodiglycol is a "key precursor for large-scale production of mustard gas" but is also used for ballpoint pen ink. *Id*.

246. Convention on the Prohibition of Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, arts. I–IX, Annex parts II–V, Jan. 13, 1993, S. Treaty Doc. No. 103–21, 1974 U.N.T.S. 45 [hereinafter Chemical Weapons Convention].

nature of the dual-use chemical presents the most difficult problem for the CWC: how to verify when parties to the CWC are in compliance, while promoting the legal use of chemicals for peaceful purposes.[247] Under the Convention, the banned weapons must be destroyed in ten years, trade with noncomplying countries is limited, and plants that produce certain chemicals must be subject to inspection as a result of the dual-use issue.[248]

Strongly implementing the CWC will further discourage the production of toxic chemicals.[249] The United States' ratification of the CWC has weakened it because the United States has not fully complied with its obligations or incorporated favorable treaty mechanisms.[250] Implementation of recommendations to strengthen the Convention would also encourage the chemical industry to look to substitutes to minimize the use of toxic chemicals.

For example, Jonathan Tucker calls for strengthening the verification regime by removing the limitations on unilateral exceptions implemented in U.S. legislation.[251] If the exceptions were removed, not only would the United States be living up to the spirit of the Convention, but also other countries might be more willing to fully participate in the Convention.[252] This may lead to increased inspections of chemical facilities and increased costs. Increased costs should encourage industry to change production processes to minimize the chemicals used or

247. *See* Moodie, *supra* note 221, at 17–19.

248. *See* Chemical Weapons Convention, *supra* note 246, at 21–32; *see also* Ian Smillie, The Kimberly Process: The Case For Proper Monitoring, *in* THE DIAMONDS AND HUMAN SECURITY PROJECT 1, 15 (Ian Smillie ed., 2002).

249. *See Chemical Weapons Convention News Alert: CWC Will Help in Fight Against Terrorism*, THE WHITE HOUSE, Mar. 20, 1997, http://www.fas.org/nuke/control/cwc/news/nwsalr12.htm. Destruction of chemical weapons as required by the CWC will limit the availability of sources for chemical weapons for terrorists. *Id.* Supplemented trade restrictions will also limit availability. *Id.* Finally, criminalization of chemical weapons possession will expand law enforcement powers to investigate. *Id.*

250. Jonathan Tucker, *The Chemical Weapons Convention: Has it Enhanced U.S. Security?*, ARMS CONTROL TODAY, Apr. 2001, http://www.armscontrol.org/act/2001_04/tucker.asp [hereinafter Tucker, *The Chemical Weapons Convention*]

251. *See id.*

252. *Id*.

substitute chemicals not on the CWC schedules of toxic chemicals.[253]

Tucker also calls for the United States to fund the Organization for the Prohibition of Chemical Weapons (OPCW).[254] This cost should instead be considered an externality of the production of chemicals covered by the schedule of chemicals in the CWC. Facilities subject to the CWC should be required to fund this treaty obligation.

Companies producing chemicals that meet these criteria could be required to pay a pro-rata share based on their production volume. This could be done using a weighted formula based on the chemical weapons schedule under which the chemical falls. For example, Schedule 1 chemicals could be subject to the highest weight because they would be subject to annual inspections under the treaty verification.[255] By passing this cost onto the chemical facilities, a truer cost to produce the chemical would emerge. This increase would add to the cost of production, driving the shift to safer chemicals, new technology, and more efficient processes.

Another way of strengthening the CWC would be to require licensing of all chemical facilities that produce, transport, store, or sell chemical weapon precursors. Legislation requiring the Department of Commerce to license facilities dealing in chemical weapon precursors has been introduced in the House of Representatives.[256] The Bill, as introduced, would require licenses for the sale, purchase, and distribution of chemical

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253. *Id*. The CWC requires inspection and reporting of information of select chemicals. Chemical Weapons Convention Implementation Act of 1998, Pub. L. 105–277, § 305, 112 Stat. 2681-856 (codified as amended at 22 U.S.C. § 6725 (2005)). Schedule 1 chemicals are toxic chemicals with little or no commercial use, Schedule 2 chemicals are chemicals with commercial and substantial potential weapons use, and Schedule 3 chemicals have significant commercial use, but can be used to make chemical weapons. *See* CENTER FOR NONPROLIFERATION STUDIES, INVENTORY OF INTERNATIONAL NONPROLIFERATION ORGANIZATIONS AND REGIMES: CONVENTION ON THE PROHIBITION OF THE DEVELOPMENT, PRODUCTION, STOCKPILING AND USE OF CHEMICAL WEAPONS, AND ON THEIR DESTRUCTION CWC-1, http://www.nti.org/e_research/official_docs/inventory/pdfs/cwc.pdf (last visited Oct. 22, 2005); 22 U.S.C. § 6701 (2005).

254. Tucker, *The Chemical Weapons Convention*, *supra* note 250.

255. 15 C.F.R. § 716.1(b)(1) (2005).

256. *See* Chemical Attack Prevention Act, H.R. 726, 108th Cong. (2003).

weapon precursors.[257] The chemicals covered under the Bill are characterized as Schedule I or Schedule II chemicals, as defined by the CWC.[258] The Bill also calls for maintaining records on the sale and distribution of covered chemicals.[259] Civil penalties for violations would also be imposed; however, the amount is rather modest at ten thousand dollars per violation.[260]

By strengthening requirements of the CWC through stronger verification regimes; requiring those producing, selling, or distributing covered chemicals to pay a pro-rata share of the OPCW funding; and requiring licensing with enhanced reporting requirements, companies will have to absorb the true cost of dealing in chemicals covered under the CWC. This increased cost and regulation will encourage those dealing with covered chemicals to invest in technology to eliminate them.

B. Tax Policies Encourage Investment

> "If you want to change behavior, tax it." – Floyd Norris[261]

Tax policies could also be used to encourage inherently safer technology.[262] By taxing the undesirable practice, the use of toxic chemicals can be discouraged.[263] This tax disincentive, combined with tax incentives, can help encourage the implementation of inherently safer technology.[264]

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257. *Id*. § 3.

258. *Id*. § 2(1) (referring to the Chemical Weapons Convention Implementation Act of 1998, 22 U.S.C. § 6701).

259. *Id*. § 5(2).

260. *Id*. § 6. Penalties increase to twenty thousand dollars for each subsequent offense. *Id*.

261. Floyd Norris, *Market Watch; In Tax Policy, Clinton Provides Hope of Change*, N.Y. TIMES, Jan. 17, 1993, at C1.

262. *See* Ashford & Zwetsloot, *supra* note 121, at 22. GOVERNMENT STRATEGIES AND POLICIES FOR CLEANER PRODUCTION 19 (1994).

263. *See* ALBERT S. MATLACK, INTRODUCTION TO GREEN CHEMISTRY 507 (2001).

264. NICHOLAS A. ASHFORD ET AL., CTR. FOR TECH., POLICY AND INDUS. DEV. AT MIT, THE ENCOURAGEMENT OF TECHNOLOGICAL CHANGE FOR PREVENTING CHEMICAL ACCIDENTS: MOVING FIRMS FROM SECONDARY PREVENTION AND MITIGATION TO PRIMARY PREVENTION VIII-18 (1993) [hereinafter ENCOURAGEMENT OF TECHNOLOGICAL CHANGE].

Current tax strategies often act as a barrier to the implementation of inherently safer technologies.[265] By punishing the users of hazardous chemicals without providing rewards for those using inherently safer technology, there is little incentive to move to inherently safer technology.[266] By taxing the user of hazardous chemicals, the cost of the hazardous chemical will increase.[267] Combining taxes on the use of hazardous chemicals with effective tax incentives should encourage investment in inherently safer technology.[268]

1. Taxes Increase Cost of Toxic Chemicals

Use of toxic chemicals could be discouraged through the use of an excise tax.[269] By increasing the cost of toxic chemicals relative to the raw material or substitute chemicals, an excise tax would discourage the use of toxic chemicals, which encourages inherently safer technology.[270] While there are many examples of excise taxes,[271] excise taxes on ozone depleting chemicals resulting from the Montreal Protocol are a prime example of how excise taxes on chemicals can encourage the use of new technology.[272]

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265. *See* Poliakoff et al., *supra* note 7, at 808 (discussing tax incentives as a barrier to a related industrial innovation, energy efficiency).

266. *See id*.

267. *See* MATLACK, *supra* note 263, at 510 (noting how taxes on certain emissions in The Netherlands have cut such emissions by 97%).

268. ENCOURAGEMENT OF TECHNOLOGICAL CHANGE, *supra* note 264, at VIII-18.

269. An excise tax imposes a duty on the manufacture, sale, or consumption of a commodity which in turn forms an indirect tax that falls on the ultimate consumer. WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY 792 (1986).

270. *See* Elizabeth R. DeSombre, *The Experience of the Montreal Protocol: Particularly Remarkable, Remarkably Particular,* 19 UCLA J. ENVTL. L. & POL'Y 49, 58 (2001).

271. In the United States, federal excise taxes are levied on many items including fuel, cigarettes, air travel, ship travel, and foreign insurance. *See* I.R.S., *Excise Taxes for 2005*, Pub. 510, Rev. Apr. 2005, *available at* http://www.irs.gov/pub/irs-pdf/p510.pdf; Alcohol and Tobacco Tax and Trade Bureau, Tax and Fee Rate, http://www.ttb.gov/alcohol/info/atftaxes.html (last visited Oct. 21, 2005) (on file with Author).

272. *See generally* DeSombre, *supra* note 270 (discussing the impact of the Montreal Protocol on the development of new technology to eliminate the use of ozone depleting chemicals).

In the United States, the excise tax implemented under the Montreal Protocol began at "$1.37 per pound multiplied by the ozone depleting potential (ODP)" of the ozone depleting chemical.[273] By 1995, the excise tax had increased to $5.35 per pound, resulting in a cost of ozone depleting chemicals that was three times the cost of the chemicals without the tax.[274] This increase suddenly made substitute chemicals and technology cost competitive and resulted in investment to switch to the safer technology.[275]

The use of excise taxes to encourage the use of inherently safer technology will not be successful if it is only limited to the United States.[276] One of the reasons the Montreal Protocol and its excise taxes on ozone depleting chemicals were successful was due to it being implemented by 170 countries.[277] Although the excise taxes in places such as Europe may not have been as high as in the United States, the gap between the ozone depleting chemicals and the alternatives were nonetheless narrowed.[278] Without this, the excise tax in the United States may not have existed.[279]

If an excise tax were promulgated on chlorine, for example, manufacturers would be encouraged to switch to safer technologies. As noted above, the excise tax would increase the cost of chlorine relative to other safer chemicals. Currently, substitute chemicals exist for some chlorine uses. For example, waste-water processors could change from chlorine to sodium hypochlorite to treat the effluent.[280] Although the Blue Plains facility justified the higher cost of switching to sodium hypochlorite with the lower risk of harm to the surrounding

273. *Id*. at 61–62.

274. *Id*.

275. *Id*.

276. *See id*. at 49, 61–62 (noting that the "unqualified success" of the Montreal Protocol was in part due to the excise tax many developed nations imposed on the use of ozone depleting substances).

277. *See id*. at 49.

278. *Id*. at 61.

279. *Id*. at 61–62.

280. *See supra* subpart V.A.2.

community,[281] an excise tax on chlorine could have instead been implemented to narrow the gap and encourage more facilities to change to safer products.[282]

Excise taxes on toxic chemicals could also encourage process intensification by encouraging facilities using toxic chemicals to utilize on-site, just-in-time, or on-demand production methods. This could produce, by far, the most dramatic results. For example, a company using chlorine in 90 ton rail cars could switch to on-site manufacturing of chlorine.[283] By moving to on-site production, storage and transportation of chlorine, commonly in 90 ton rail cars, would be eliminated.[284] By eliminating transportation and storage of chlorine, a chemical that has a vulnerable zone of up to 25 miles, the risks associated with the use of chlorine would be greatly reduced.[285] The facility using the chlorine would now store a more benign raw material, brine, presenting minimal safety and security risks and avoiding the excise tax because it no longer purchases chlorine.[286]

2. *Tax Incentives Encourage Investment*

Inherently safer technology can also be encouraged through incentives to encourage investment. Two methods to encourage investment include changes to depreciation rules and the introduction of special investment tax credits.[287] Changes to depreciation rules for investments in inherently safer technology could encourage the implementation of new technology.[288] Investment tax credits could be used to specifically target

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281. *Id*.

282. *See id*.

283. *See* Chemie.DE Info. Serv., *Akzo Nobel Closes Down Chlorine Production in Bohus, Sweden*, Sept. 15, 2004, http://www.chemie.de/news/e/39587/?sort=3 (reporting chlorine plant closing because main customer is building chlorine generation facility on-site).

284. KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 46–47; Joseph R. Biden, Jr., U.S. Senator for Delaware, Floor Statement: The Urgent Need for Rail Security at the U.S. Senate (Jul. 14, 2005) (addressing pressing need for added security or rerouting regarding common 90 ton chemical tankers).

285. *See supra* subpart V.A.2.

286. KLETZ, PLANT DESIGN FOR SAFETY, *supra* note 125, at 47.

287. ENCOURAGEMENT OF TECHNOLOGICAL CHANGE, *supra* note 264, at VIII-18.

288. *Id*.

investment in inherently safer technology.[289]

To encourage investment in inherently safer technology, changes to the depreciation rules for new capital projects and existing facilities are necessary.[290] While accelerated depreciation would be particularly useful in encouraging new capital investment in inherently safer technology, elimination or reduction of depreciation for old facilities is needed.[291] Accelerated depreciation schedules for existing plants that abandon existing facilities utilizing toxic chemicals will allow the company to recover a portion of the money already invested in the facility, while reduction or elimination of depreciation for the acquisition of old facilities would encourage those facilities to be retired.[292]

To encourage investment in new technology, investment tax credits specifically targeting inherently safer technology should be enacted.[293] While empirical studies showing the effectiveness of investment tax credits have had mixed results, investment tax credits are generally considered "effective means of prompting targeted investment behavior."[294]

Currently, many investment tax credits fall under the general business credit.[295] By adding investment in inherently safer technology as a general business credit, companies investing in inherently safer technology will be able to reduce their tax liability dollar for dollar.[296] This reduction will improve the performance, or rate of return, of the new investment, thus encouraging the investment.[297]

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289. *Id*.

290. *Id*.

291. *See id*. (discussing the benefits of reducing depreciation taken by purchasers of antiquated chemical plants).

292. *See id*. (suggesting that reduced depreciation for acquisition of old chemical plants would encourage new plants to be built).

293. *Id*.

294. Robert Rosacker & Richard Metcalf, *United States Federal Tax Policy Surrounding the Investment Tax Credit: A Review of Legislative Intent and Empirical Research Findings Over Thirty Years (1962–1991)*, 9 AKRON TAX J. 59, 77 (1992).

295. *See* General Business Credit, I.R.C. § 38(b) (2005) (listing the different general business credits for select investments).

296. *See* Rosacker & Metcalf, *supra* note 296, at 61–62.

297. *Id*.

C. Limited Liability Encourages Risk Reduction

Studies have shown the economic costs incurred by companies liable for chemical accidents are not prohibitively high.[298] The liability costs for chemical accidents incurred by companies using or producing chemicals is estimated to comprise less than seventy percent of the total social cost of the resulting damage and injuries.[299] Limitations on the damage awards provided by the tort system do not encourage industry to invest in inherently safer technology.[300] While the tort system may not give adequate economic signals, it has not stopped law suits by those injured.

In the wake of the September 11 attacks, lawsuits were filed against airlines, ports, and airline manufacturers.[301] In response to the lawsuits, Congress passed the Support Anti-Terrorism by Fostering Effective Technologies Act of 2002 (SAFETY Act).[302] The SAFETY Act sought to encourage the design and marketing of safety technology by providing the product marketer with limited tort risk.[303] Promulgation of similar legislation could be used to encourage the industry to implement inherently safer technology improvements.

The SAFETY Act provides companies that sell approved antiterrorism technology with benefits involving mitigation of tort risk.[304] The Act requires the seller of antiterrorism technology to submit an application to the Department of Homeland Security for certification of the anti-terrorism technology.[305] Once approved, the seller receives protections that minimize its tort liability following a terrorist act.[306] The

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298. *See* ENCOURAGEMENT OF TECHNOLOGICAL CHANGE, *supra* note 264, at VII-10.

299. *Id*.

300. *See id*. at VII-10 to -11.

301. Central Broadcasting Service, *Judge: 9/11 Lawsuits Can Proceed*, Sept. 9, 2003, http://www.cbsnews.com/stories/2003/09/09/national/main572343.shtml.

302. *See* 6 U.S.C. §§ 441–442 (2005).

303. Raymond B. Biagini, *Invoking the Safety Act: A Matter of Corporate Responsibility and Competitive Edge*, 39 THE PROCUREMENT LAW. 1, 24 (2004) (discussing mitigation of tort risk through the SAFETY Act).

304. 6 U.S.C. § 441(b).

305. *Id*. § 442(d).

306. *Id*. § 442.

SAFETY Act provides:

- The suit can only be filed in Federal Court;
- The suit will immediately be dismissed unless the plaintiff can prove that the seller acted fraudulently or with willful misconduct in obtaining the Department of Homeland Security certification;
- For no punitive damages; and
- Liability is limited to the amount of insurance coverage, provided the seller has obtained the requisite insurance.[307]

Legislation modeled after the SAFETY Act could be used as an incentive to encourage the chemical industry to implement inherently safer technology. Like the SAFETY Act, legislation should provide for elimination or minimization of tort liability, no punitive damages, and exclusive federal jurisdiction for adoption of inherently safer technology. The lower liability exposure should lead to lower costs for the chemical manufacturer, such as lowered insurance premiums.

Implementation of inherently safer technology should reduce the risks associated with the use of toxic chemicals and lead to reduced insurance premiums.[308] The chemical industry developed the Responsible Care program in response to rising insurance premiums.[309] Responding to the Program, the insurance industry recognized that with safer systems in place, the chemical industry would be more likely to prevent environmental damage and thus less likely to be liable.[310] Likewise, inherently safer technology will present lower risks, thus limiting the chemical industry's liability.

VII. CONCLUSION

While it is difficult for terrorists to acquire military-grade chemical weapons, toxic industrial chemicals are "ubiquitous in modern industrial society and are more accessible to terrorists

307. *See id*.

308. *See* ENCOURAGEMENT OF TECHNOLOGICAL CHANGE, *supra* note 264, at VII-11.

309. Gunningham, *supra* note 9, at 402.

310. *See id.*

than either biological or fissile materials."[311] With the abundance of toxic industrial chemicals, we can only assume that terrorist attacks against people and commercial assets will occur in the future.[312] The attacks of 9/11 illustrate the emerging threats, which can cause mass disruption and casualties.[313] These threats pose serious harms to the domestic and global economy.[314]

It is critical to minimize the vulnerabilities that may attract terrorists to use chemical facilities as weapons of mass destruction.[315] Current methods to harden facilities by increasing security and increasing the level of preparedness to respond to an accident will minimize the vulnerability; however, it will not eliminate the threat.[316]

The required hardening of chemical plants is a good start, but the increased security measures have not been fully successful.[317] We need to continue with the efforts of the industry and to work with Government to implement vulnerability assessments. The proper tools must be in place to respond to an accident should an attack or accidental release occur. Current legislative efforts have addressed this issue.

Inherently safer technology will not answer the safety problem overnight. It will require a shift in the culture of the chemical industry.[318] Due to the many barriers to adopting inherently safer technology, no single policy will encourage its

311. *See* JONATHON B. TUCKER, CENTER FOR NONPROLIFERATION STUDIES, CHEMICAL TERRORISM: ASSESSING THREATS AND RESPONSES, *in* HIGH IMPACT TERRORISM, 117 (Florence Poillon et al. eds., 2002).

312. *See* COMM. ON CHALLENGES FOR THE CHEM. SCI. IN THE 21ST CENTURY, NATIONAL SECURITY AND HOMELAND DEFENSE: CHALLENGES FOR THE CHEMICAL SCIENCES IN THE 21ST CENTURY 14 (2003) [hereinafter CHALLENGES FOR THE CHEMICAL SCIENCES].

313. U.S. GOV'T ACCOUNTING OFFICE, HOMELAND SECURITY: A FRAMEWORK FOR ADDRESSING THE NATIONS EFFORTS 2, GAO-01-1158T (2001).

314. *Id.* (discussing the fall of the New York Stock Exchange by more than six hundred points following the 9/11 attacks).

315. CHALLENGES FOR THE CHEMICAL SCIENCES, *supra* note 312, at 14.

316. *See* ENCOURAGEMENT OF TECHNOLOGICAL CHANGE, *supra* note 264, at 1. Current methods of secondary prevention and mitigation will reduce the probability and seriousness of an accident; however, they cannot eliminate the risk of an accident. *Id*.

317. *See supra* subpart IV.D.3.

318. ENCOURAGEMENT OF TECHNOLOGICAL CHANGE, *supra* note 264, at I-6.

adoption.[319] Therefore, a broad based policy addressing the barriers should be promulgated.[320] This Paper proposes three policy options: (1) strengthening the CWC, (2) tax policy changes, and (3) limited liability for facilities that implement inherently safer technology. Others have proposed many areas that should also be considered.[321] A policy that addresses all of the barriers will encourage firms to implement inherently safer technology.

*James L. Beebe**

319. *See id.* at I-5 to -6.

320. *See id*. at I-6.

321. *See generally* ROBERT J. LAMPERT ET AL., OFFICE OF SCI. AND TECH. POLICY, NEXT GENERATION ENVIRONMENTAL TECHNOLOGIES: BARRIERS AND BENEFITS (2003), *available at* http://www.rand.org/publications/MR/MR1682/MR1682.pref.pdf. (examining twenty-five different next-generation environmental technologies).

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